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Coblation versus other surgical techniques for tonsillectomy (Review)

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[Intervention Review]

Coblation versus other surgical techniques for tonsillectomy

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ABSTRACT

Background

Tonsillectomy is a very common operation and is performed using various surgical methods. Coblation is a popular method because it purportedly causes less pain than other surgical methods. However, the superiority of coblation is unproven.

Objectives

To compare the effects of coblation tonsillectomy for chronic tonsillitis or tonsillar hypertrophy with other surgical techniques, both hot and cold, on intraoperative morbidity, postoperative morbidity and procedural cost.

Search methods

The Cochrane ENT Information Specialist searched the ENT Trials Register; Central Register of Controlled Trials (CENTRAL 2017, Issue 3); PubMed; Ovid Embase; CINAHL; Web of Science; ClinicalTrials.gov; ICTRP and additional sources for published and unpublished trials. The date of the search was 20 April 2017.

Selection criteria

Randomised controlled trials (RCTs) of children and adults undergoing tonsillectomy with coblation compared with any other surgical technique. This review is limited to trials of extracapsular (traditional) tonsillectomy and excludes trials of intracapsular tonsil removal (tonsillotomy).

Data collection and analysis

We used the standard Cochrane methods. Our primary outcomes were: patient-reported pain using a validated pain scale at postoperative days 1, 3 and 7; intraoperative blood loss; primary postoperative bleeding (within 24 hours) and secondary postoperative bleeding (more than 24 hours after surgery). Secondary outcomes were: time until resumption of normal diet, time until resumption of normal activity, duration of surgery and adverse effects including blood transfusion and the need for reoperation. We used GRADE to assess the quality of the evidence for each outcome; this is indicated in *italics*.

Main results

We included 29 studies, with a total of 2561 participants. All studies had moderate or high risk of bias. Sixteen studies used an adequate randomisation technique, however the inability to mask the surgical teams and/or provide adequate methods to mitigate the risk of bias put nearly all studies at moderate or high risk of detection and measurement bias for intraoperative blood loss, and primary and secondary bleeding. In contrast most studies (20) were at low risk of bias for pain assessment. Most studies did not report data in a manner permitting meta-analysis.

Most studies did not clearly report the participant characteristics, surgical indications or whether patients underwent tonsillectomy or adenotonsillectomy. Most studies reported that tonsillitis (infection) and/or tonsillar hypertrophy (obstruction) were the indication for surgery. Seven studies included only adults, 16 studies included only children and six studies included both.

Pain

At postoperative day 1 there is *very low quality evidence* that patients in the coblation group had less pain, with a standardised mean difference (SMD) of -0.79 (95% confidence interval (CI) -1.38 to -0.19; 538 participants; six studies). This effect is reduced a SMD of -0.44 (95% CI -0.97 to 0.09; 401 participants; five studies; *very low-quality evidence*) at day 3, and at day 7 there is *low quality evidence* of little or no difference in pain (SMD -0.01, 95% CI -0.22 to 0.19; 420 participants; five studies). Although this suggests that pain may be slightly less in the coblation group between days 1 and 3, the clinical significance is unclear.

Intraoperative blood loss

Methodological differences between studies in the measurement of intraoperative blood loss precluded meta-analysis.

Primary and secondary bleeding

The risk of primary bleeding was similar (risk ratio (RR) 0.99, 95% CI 0.48 to 2.05; 2055 participants; 25 studies; *low-quality evidence*). The risk of secondary bleeding was greater in the coblation group with a risk ratio of 1.36 (95% CI 0.95 to 1.95; 2118 participants; 25 studies; *low-quality evidence*). Using the median of the control group as the baseline risk, the absolute risk in the coblation group was 5% versus 3.6% in the control group. The difference of 1.3% has a 95% CI of 0.2% lower in the coblation group to 3.5% higher.

Secondary outcomes

Differences in study design and data reporting precluded the identification of differences in the time to resumption of normal diet or activity, or whether there was a difference in the duration of surgery.

Although we could not feasibly compare the costs of equipment or operative facility, anaesthetic and surgical fees across different healthcare systems we used duration of surgery as a proxy for cost. Although this outcome was commonly reported in studies, it was not possible to pool the data to determine whether there was a difference.

Adverse events other than bleeding were not well reported. It is unclear whether there is a difference in postoperative infections or the need for reoperation.

Authors' conclusions

The coblation technique may cause less pain on postoperative day 1, but the difference is small and may be clinically meaningless. By postoperative day 3, the difference decreases further and by postoperative day 7 there appears to be little or no difference. We found similar rates of primary bleeding but we cannot rule out a small increased risk of secondary bleeding with coblation. The evidence supporting these findings is of *low* or *very low quality*, i.e. there is a very high degree of uncertainty about the results. Moreover, for most outcomes data were only available from a few of the 29 included studies.

The current evidence is of very low quality, therefore it is uncertain whether or not the coblation technique has any advantages over traditional tonsillectomy techniques. Despite the large number of studies, failure to use standardised or validated outcome measures precludes the ability to pool data across studies. Therefore, well-conducted RCTs using consistent, validated outcome measures are needed to establish whether the coblation technique has a benefit over other methods. In the included studies we identified no clear difference in adverse events. However, given the rarity of these events, randomised trials lack the power to detect a difference. Data from large-scale registries will provide a better estimate of any difference in these rare outcomes.

PLAIN LANGUAGE SUMMARY

Surgical removal of the tonsils (tonsillectomy) with coblation or another surgical method

Review question

This review compared the coblation method with other methods of tonsil removal to assess recovery following tonsillectomy or adenotonsillectomy.

Background

Surgical removal of the tonsils (tonsillectomy) is a very common operation. Patients may have pain for up to two weeks after surgery. Bleeding may occur either immediately after surgery ('primary bleeding' within 24 hours of surgery) or later ('secondary bleeding' more than 24 hours after surgery). There are many methods of tonsillectomy; the traditional method is with metal surgical instruments. Coblation is a new method where the surgeon uses an electrically powered handpiece that 'burns' tissues using low temperatures.

Study characteristics

This review included evidence available up to April 2017. We included 29 studies, with a total of 2561 participants. All studies had a moderate or high risk of bias. Seven studies included adults, 16 studies included children and six included both adults and children.

Most studies measured pain using a patient-reported scale (for example, asking people to rate their pain on a scale of 1 to 10).

Key results

The coblation technique may cause slightly less pain one day after surgery and three days after surgery, but it is unlikely that there is a difference in pain seven days after surgery. We are very uncertain whether the amount of pain reduction observed in days 1 to 3 after surgery would be important to patients.

There is little or no difference in the risk of bleeding in the first day after surgery, but there may be a small increased risk of bleeding with coblation after the first day. For every 1000 patients having a tonsillectomy, 50 patients would have a bleed with coblation, compared to 36 with traditional surgical techniques.

Quality of the evidence

The evidence for the difference in pain is of *low or very low quality* and for the difference in bleeding after surgery it is of *low quality*. This means that we have little confidence in the results; the true effect may be very different - we simply do not know at this stage.

Summary of findings for the main comparison. Coblation versus other surgical techniques for tonsillectomy

Coblation versus other surgical techniques for tonsillectomy

Patient or population: patients requiring tonsillectomy (any diagnosis)
Setting: hospitals
Intervention: coblation
Comparison: alternative tonsillectomy techniques (including 'cold' and 'hot' techniques)

Outcomes	Relative effect (95% CI)	Anticipated absolute effects* (95% CI)			Quality of the evidence (GRADE)	What happens
		Without coblation	With coblation	Difference		
Pain postoperative day 1 № of participants: 538 (6 studies)	—	—	—	Pain score was lower by a standardised mean difference (SMD) of 0.79 (1.38 lower to 0.19 lower) in the coblation group	⊕⊝⊝⊝ very low	There seems to be less pain with coblation (a small effect) but it is unclear whether this difference is important to patients. There is very little research on the minimal clinically important difference for acute post-surgical pain to support interpretation. Our confidence in the estimate is very low because of high risk of bias within studies, statistical heterogeneity, imprecision of the estimate and reporting bias.
Pain postoperative day 3 № of participants: 401 (5 studies)	—	—	—	Pain score was lower by a SMD of 0.44 (0.97 lower to 0.09 higher)	⊕⊝⊝⊝ very low	There seems to be slightly less pain with coblation (a very small effect). There is very little research on the minimal clinically important difference for acute post-surgical pain to support interpretation. Our confidence in the estimate is very low because of high risk of bias within studies, statistical heterogeneity, imprecision of the estimate and reporting bias.
Pain postoperative day 7 № of participants: 420 (5 studies)	—	—	—	Pain score was lower by a SMD of 0.01 (0.22 lower to 0.19 higher)	⊕⊕⊝⊝ low	There seems to be no clinically significant difference in pain with coblation, but our confidence in the estimate is low because of high risk of bias within studies and reporting bias, based on the small proportion of studies that reported data in a manner that permitted meta-analysis. However, unlike the data on postoperative day 1 and postoperative day 3, there was no heterogeneity or inconsistency observed in the data.

Intraoperative blood loss № of participants: 781 (9 studies)	—	—	—	Not estimable	⊕⊖⊖⊖ very low	Only 9 studies reported sufficient information for meta-analysis. However, these could not be pooled because different methods and parameters were used. Of these studies, 7 showed lower bleeding in the coblation group but the importance of this was difficult to interpret.
Primary bleeding № of participants: 2055 (25 studies)	RR 0.99 (0.48 to 2.05)	Study population 1.1%	1.1% (0.5 to 2.2)	0.0% fewer (0.6 fewer to 1.1 more per 100 people)	⊕⊕⊖⊖ low	There seems to be no clinically significant difference in the risk of primary bleeding with coblation but our confidence in the evidence is low because of high risk of bias within studies and imprecision of the estimate.
Secondary bleeding № of participants: 2118 (25 studies)	RR 1.36 (0.95 to 1.95)	Study population 3.6%	5.0% (3.5 to 7.1)	1.3% higher (0.2 lower to 3.5 higher per 100 people)	⊕⊕⊖⊖ low	There seems to be a slightly higher risk of secondary bleeding with coblation, but our confidence in the evidence is low because of high risk of bias within studies and imprecision of the estimate.

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; **SMD:** standardised mean difference

GRADE Working Group grades of evidence
High quality: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

BACKGROUND

Description of the condition

Tonsillectomy is one of the most commonly performed surgical procedures, with the number of tonsillectomies performed per year increasing over recent decades (Erickson 2009). Most tonsillectomies are performed for recurrent tonsillitis or adenotonsillar hypertrophy that results in sleep-disordered breathing (Baugh 2011). The procedure is performed in both adults and children and is associated with significant postoperative morbidity. Multiple surgical techniques are used in practice, without consensus on the optimal technique or instrumentation.

Tonsillectomy entails complete removal of the palatine tonsils through dissection in the peritonsillar space. The procedure is often combined with adenoidectomy (surgical removal of the adenoid tissue from the nasopharynx), especially when the procedure is performed for the surgical management of sleep-disordered breathing.

Although commonly performed, tonsillectomy is associated with significant morbidity. The risks of the procedure include the risks of general anaesthesia and risks specific to tonsillectomy. The most common risks specific to the procedure are pain and postoperative bleeding. Postoperative bleeding may occur in the immediate postoperative period or in a delayed fashion (Bhattacharyya 2014). Postoperative pain lasts approximately two weeks and may delay resumption of normal activity and diet with the risk of dehydration. In severe cases, postoperative pain may result in delayed discharge, an emergency department visit or readmission for pain control and hydration.

Bleeding following tonsillectomy is a potentially fatal complication. The National Prospective Tonsillectomy Audit (NPTA) collected information on 33,921 patients undergoing tonsillectomy in England and Northern Ireland over a 14-month period in 2003 to 2004. The primary (within 24 hours) and secondary (after 24 hours) bleeding rates were 0.6% and 3% respectively (BAO-HNS/RCSENG 2005; van der Meulen 2004).

The morbidity associated with adenoidectomy is much less than that associated with tonsillectomy and for this reason trials of tonsillectomy with or without adenoidectomy are included in this review. When relevant outcomes were expected to differ between groups based on their adenoidectomy status, we planned subgroup analysis. Surgical indication does not determine tonsillectomy technique, therefore we did not plan subgroup analysis based on indication.

Several techniques for tonsillectomy exist and their relative effectiveness is debated. The technique chosen often depends on the surgeon's personal preference.

The techniques employed for tonsillectomy include the following:

- Cold dissection: the peritonsillar space is dissected with metal instruments, with bleeding typically controlled by ligation or electrocautery.
- Hot dissection: an instrument delivering thermal energy is used to dissect the peritonsillar space. Examples include:
  - electrosurgery: radiofrequency energy is applied via means of an instrument, with the resulting heat providing control of bleeding and dissection of tissues;
  - quantum molecular resonance: electrical energy is used to deliver energy quanta that divide tissue by breaking molecular bonds at low temperatures (< 50°C) (D'Agostino 2008);
  - coblation (see below).

Description of the intervention

Coblation (cold ablation, cool ablation, ionised field ablation, plasma-mediated ablation, radiofrequency ablation or low-temperature plasma excision) is a tonsillectomy technique first developed for use in orthopaedic surgery. Coblation is an example of high-frequency electrosurgery. The technique involves passing radiofrequency energy through a conductive medium (such as isotonic sodium chloride) producing a plasma field. The resultant energetic charge-carrying ions have sufficient energy to break organic molecular bonds, resulting in low-temperature (40°C to 70°C compared with > 100°C in electrosurgery) molecular disintegration of the tissue. A bipolar probe, known as a coblation wand, is used to accomplish the dissection. The low operating temperatures purportedly cause less postoperative pain compared with techniques involving higher temperatures (Timms 2002). Many coblation devices also coagulate bleeding vessels.

This review only includes studies that describe tonsillectomy (also known as extracapsular tonsillectomy or total tonsillectomy) and excludes studies that describe tonsillotomy (also known as intracapsular tonsillectomy or partial tonsillectomy). Tonsillectomy refers to an extracapsular dissection to completely remove the palatine tonsil, leaving bare pharyngeal musculature (the authors acknowledge that the tissue is part of Waldeyer's ring and can be contiguous with the lingual tonsillar tissue). In contrast, tonsillotomy leaves a rim of tonsillar tissue and does not expose pharyngeal musculature. While there is a risk of imprecision with the terminology, this review relies on the terms and descriptions of the procedures provided in the studies and we clarified this with study authors when needed.

Coblation® is a registered trademark of ArthroCare Corporation, Sunnyvale, CA, USA. This company's products have been used in all of the included studies described in this review, based on the terms and descriptions in each of the included studies.

How the intervention might work

As the purported advantages of coblation involve the low-temperature dissection of tissue afforded while preserving haemostasis, we planned subgroup analyses based on the cold versus hot dissection techniques as listed above. Hot techniques are those in which an instrument delivers thermal energy to the tissue in order to facilitate tissue dissection. Similarly, we planned to evaluate intraoperative bleeding, as this outcome is dependent on the technique employed for tonsil removal.

Why it is important to do this review

This is an update of a Cochrane Review first published in the*Cochrane Library* in Issue 3, 2007 (Burton 2007). The prior

review identified insufficient evidence to conclude whether use of coblation provides a benefit over other tonsillectomy techniques. Evidence on this topic would help clinicians to select a technique for tonsillectomy. Recently, concerns about the metabolism of narcotic analgesia in paediatric patients has heightened awareness of postoperative pain in children (Ciszkowski 2009). A technique that offers less morbidity, perhaps less pain, less bleeding or a shorter duration of surgery would have obvious advantages for the patient and healthcare systems.

OBJECTIVES

To compare the effects of coblation tonsillectomy for chronic tonsillitis or tonsillar hypertrophy with other surgical techniques, both hot and cold, on intraoperative morbidity, postoperative morbidity and procedural cost.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) in which the patient was the unit of randomisation. We excluded trials in which tonsils were randomised. We also excluded quasi-randomised trials.

Types of participants

Adults or children undergoing elective tonsillectomy, in a day-case or inpatient setting. We included trials where adenoidectomy or ventilation tube (grommet) insertion were undertaken concurrently. We excluded trials in which tonsillectomy was performed for tumour biopsy, abscess drainage, with concurrent uvulopalatopharyngoplasty or as an emergency for any reason.

Types of interventions

Coblation tonsillectomy (involving a radiofrequency device that creates a saline plasma field generated by bipolar electrodes).

The main comparators were: traditional 'cold' techniques of dissection, electrosurgery with monopolar cautery, bipolar cautery, molecular resonance, harmonic scalpel, laser, PlasmaKnife and harmonic ultrasound.

The main comparison pairs were:

- coblation *versus* any other dissection technique;
- coblation *versus* any 'cold' dissection technique;
- coblation *versus* any 'hot' (cautery) dissection technique.

This review is limited to trials of extracapsular (traditional) tonsillectomy and excludes trials of intracapsular tonsil removal (tonsillotomy).

Types of outcome measures

We analysed the following outcomes in the review. We did not exclude studies solely because they lacked data related to these outcomes.

Primary outcomes

- Postoperative pain as measured using a validated pain scale at 1, 3 and 7 days.
- Intraoperative blood loss (mL).
- Adverse effects: primary bleeding (within 24 hours postoperatively) and secondary bleeding (> 24 hours postoperatively).

Secondary outcomes

- Time until resumption of normal diet (days).
- Time until resumption of normal activity (days).
- Duration of surgery (minutes).
- Adverse effects: e.g. infection, blood transfusion or need for reoperation.

We chose to report postoperative pain at postoperative days 1, 3 and 7 because we felt that these were clinically relevant time points. Postoperative days 1 and 3 would represent a time of very high pain early in the postoperative period, and postoperative day 7 would represent a time when the patient may have noted substantial improvement.

Search methods for identification of studies

The Cochrane ENT Information Specialist conducted systematic searches for randomised controlled trials and controlled clinical trials. There were no language, publication year or publication status restrictions. The date of the search was 20 April 2017.

Electronic searches

The Information Specialist searched:

- the Cochrane ENT Trials Register (searched 20 April 2017);
- the Cochrane Central Register of Controlled Trials (CENTRAL 2017, Issue 3);
- PubMed (1946 to 20 April 2017);
- Ovid EMBASE (1974 to 20 April 2017);
- Ovid CAB Abstracts (1910 to 20 April 2017);
- EBSCO CINAHL (1982 to 20 April 2017);
- LILACS, lilacs.bvsalud.org (searched 20 April 2017);
- KoreaMed, www.koreamed.org (searched 21 April 2017);
- IndMed, www.indmed.nic.in (searched 21 April 2017);
- PakMediNet, www.pakmedinet.com (searched 21 April 2017);
- Web of Knowledge, Web of Science (1945 to 20 April 2017);
- CNKI, http://www.cnki.com.cn/index.htm (searched via Google Scholar 21 April 2017);
- ClinicalTrials.gov (searched via the Cochrane Register of Studies 20 April 2017);
- World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP), www.who.int/ictrp (searched 20 April 2017);
- ISRCTN, www.isrctn.com (searched 21 April 2017).

In searches prior to 2013, we also searched BIOSIS Previews 1926 to July 2012. In searches prior to 2017 we also searched Google.

The Information Specialist modelled subject strategies for databases on the search strategy designed for CENTRAL. Where appropriate, they were combined with subject strategy adaptations of the highly sensitive search strategy designed by Cochrane for identifying randomised controlled trials and controlled clinical trials (as described in the *Cochrane Handbook for Systematic*

Reviews of Interventions Version 5.1.0, Box 6.4.b. (Handbook 2011). Search strategies for major databases including CENTRAL are provided in Appendix 1.

Searching other resources

We scanned the reference lists of identified publications for additional trials and contacted trial authors where necessary. In addition, the Information Specialist searched PubMed and the*Cochrane Library* to retrieve existing systematic reviews relevant to this systematic review, so that we could scan their reference lists for additional trials. The Information Specialist also ran non-systematic searches of Google Scholar for grey literature and other potential sources of trials.

Data collection and analysis

Selection of studies

Two authors scanned the search results by reviewing titles and abstracts to identify possibly relevant studies. For any possibly relevant study two authors independently performed full text review, including verification that tosillectomy was the surgical procedure based on the terms and descriptions provided by the study authors. We documented studies that were excluded based on full-text review, along with the reason for exclusion, in the Characteristics of excluded studies table. We resolved any differences through discussion and consensus with a third author.

Data extraction and management

Two review authors independently extracted data from each study using a standardised data collection form. We resolved differences through discussion with a third author or a methodologist (LYC). We extracted data related to study source, patient inclusion and exclusion criteria, study design, sequence generation, allocation concealment, blinding of research personnel and patients, number of participants in each group, surgical technique in each group, outcomes collected and outcomes reported, loss to follow-up, and correspondence required and responses received from study authors.

Assessment of risk of bias in included studies

Two review authors independently assessed the risk of bias of each included study. We followed the guidance in the *Cochrane Handbook for Systematic Reviews of Interventions* (Handbook 2011), and we used the Cochrane 'Risk of bias' tool to assess the risk of bias as 'low', 'high' or 'unclear' for each of the following six domains:

- sequence generation;
- allocation concealment;
- blinding of participants, personnel and outcome assessment;
- incomplete outcome data;
- selective reporting;
- other sources of bias.

Measures of treatment effect

Barring excessive clinical heterogeneity, we pooled treatment results across studies. We expressed treatment differences for dichotomous outcomes (proportion of patients with postoperative bleeding) as a risk ratio (RR) with 95% confidence interval (CI). We also expressed the results in the 'Summary of findings' table as absolute effects with 95% CIs based on the pooled results and compared to the assumed risk. This assumed baseline risk is typically either (a) the median of the risks of the control groups in the included studies, this being used to represent a 'medium-risk population' or, alternatively, (b) the average risk of the control groups in the included studies is used as the 'study population' (Handbook 2011). Should further studies be added in future updates it may also be appropriate to consider assumed baseline risk in (c) a low-risk population and (d) a high-risk population.

We expressed treatment effects for continuous scales as the mean difference (MD) with standard deviation (SD) or if different scales were used to measure the same outcome, we used the standardised mean difference (SMD).

Unit of analysis issues

We excluded trials in which tonsils (right versus left) rather than patients were randomised. We also excluded trials with non-standard designs, such as cross-over and cluster-randomised trials.

Dealing with missing data

Many studies contained unclear methods and reported insufficient results. We systematically attempted to contact study authors for clarification and to obtain critical data such as point estimates or variance estimates necessary for meta-analysis. We did not plan imputations for missing data, apart from standard calculations to obtain SD values for continuous data as detailed in the *Cochrane Handbook for Systematic Reviews of Interventions* (Handbook 2011). We extracted and analysed all data using the available case analysis method, with the exception of data for secondary bleeding. We assumed that every patient with clinically relevant secondary bleeding would seek emergency help. Therefore, for this outcome we used the number randomised as the denominator. We excluded from the meta-analysis studies with insufficient data to permit calculation of SD values. These studies are included in qualitative analysis only.

Assessment of heterogeneity

Clinical and statistical heterogeneity are distinct concepts that we analysed separately. We assessed clinical heterogeneity by considering between-study differences in the patients, surgical interventions and outcome measures. We assessed statistical heterogeneity by visually inspecting the forest plots and considering the Chi^2 test (with a significance level set at $P < 0.10$) and the I^2 statistic, which calculates the percentage of variability that is due to heterogeneity rather than to chance, with I^2 values over 50% suggesting substantial heterogeneity (Handbook 2011).

Assessment of reporting biases

We assessed reporting bias as *between-study publication bias* and *within-study outcomes reporting bias.*

Outcomes reporting bias (within-study reporting bias)

We assessed within-study reporting bias by comparing the outcomes reported in the published report against the study protocol, if available. In the absence of a study protocol, we compared the outcomes listed in the methods section of each study with the results reported. If results were reported in a manner insufficient for meta-analysis we sought further information from the study authors. For example, many studies reported that a result

was 'significant' without providing a point estimate or variance. Frequently we had insufficient information to judge the risk of bias and rated this as 'unclear' risk of bias (Handbook 2011).

Publication bias (between-study reporting bias)

We drew funnel plots (plots of the effect estimates versus the inverse of their standard errors (SE)) when sufficient studies (> 10) were available. Asymmetry of the funnel plot may indicate publication bias or bias related to sample size, although asymmetry may also represent a true relationship between study size and size of treatment effect. We planned a formal investigation of the degree of asymmetry with the method proposed by Egger 1997 and Harbord 2006 using the StatsDirect software.

Data synthesis

In the absence of excessive clinical heterogeneity, we pooled data across studies to calculate a summary measure of effect (see Measures of treatment effect).

For dichotomous data, we planned to analyse pooled data using the Mantel-Haenszel method to calculate a risk ratio (RR) or using time-to-event analysis to calculate a hazard ratio (HR). In this review, time-to-event analysis would have been suitable for time to resumption of normal diet or activities.

For continuous data, we planned to analyse pooled data using the inverse variance method. We calculated the mean difference (MD) or standardised mean difference (SMD) as summary measures of effect. We used the MD if the unit of outcome was measured consistently across studies. We used the SMD if there was inconsistency across studies. Of note, the SMD does not automatically account for differences in the direction of scales, but the analysis of our outcomes is not impacted by this issue.

For most outcomes we planned to use a random-effects meta-analysis method (DerSimonian and Laird), theorising that the outcomes between different surgical techniques for tonsillectomy are not the same between surgeons and across patient populations due to unmeasured differences in patients, institutions and surgical techniques. Random-effects versus fixed-effect methods yield trivial differences when statistical heterogeneity is low. However, when statistical heterogeneity is high a random-effects method provides a more conservative estimate of the difference. When possible, we planned to differentiate between 'statistically significant' and 'clinically significant' findings. We performed all meta-analyses with Review Manager 5.3 (RevMan 2014).

Subgroup analysis and investigation of heterogeneity

We identified possible effect modifiers a priori for subgroup analyses:

- Comparator technique of tonsillectomy ('hot' versus 'cold' techniques).
- Patient age (children versus adults).
- Type of surgery (tonsillectomy only versus tonsillectomy and adenoidectomy).

For the subgroup analysis based on tonsillectomy technique used in the control group, we considered monopolar cautery, bipolar cautery, molecular resonance, laser, PlasmaKnife and harmonic scalpel as hot techniques because there is at least some heat associated with the procedure. If there were sufficient studies we had planned to conduct individual subgroup analysis for each technique (monopolar, bipolar, molecular resonance, harmonic scalpel).

Where data from adults and children were separable, we planned to analyse them as subgroups provided this would not break the randomisation (e.g. studies with stratified randomisation for adults versus children). Otherwise studies that enrolled both adults and children would be considered 'mixed' unless one of the group predominated; e.g. if 80% of patients in a study were children, this study would have been grouped as 'children'.

Sensitivity analysis

We planned sensitivity analyses to determine whether the findings were robust to decisions made in the course of identifying, screening and analysing the studies. We planned to evaluate these factors:

- Impact of model chosen: fixed-effect versus random-effects model.
- Source of data: published versus unpublished studies for which data were obtained solely from abstracts/personal communication.
- Risk of bias of included studies:
  - selection bias: studies with high risk of bias for methods of allocation concealment and randomisation;
  - attrition bias: loss to follow-up > 10%, or differential loss to follow-up between treatment arms.
- Method of measurement for duration of surgery and operative blood loss. For example, in many studies it was unclear whether the reported measures of duration of surgery or blood loss included the time and blood loss from concurrent adenoidectomy. Similarly, many studies did not indicate how intraoperative blood loss was assessed for the coblation group and did not specify whether the volume of saline irrigant, required for coblation, was subtracted from the measured blood loss.
- Clinical factors: surgical indication - the effect of infection versus obstruction.

If important differences were found in any of these analyses, we planned to summarise them in tables and discuss this in the Effects of interventions section.

GRADE and 'Summary of findings'

We used the GRADE approach to rate the overall quality of evidence for each outcome. The quality of evidence reflects the extent to which we are confident that an estimate of effect is correct and we used in the interpretation of the results. There are four possible quality ratings: 'high', 'moderate', 'low' and 'very low'. A rating of 'high quality' implies that we are confident in our estimate of effect and that further research is very unlikely to change our confidence in the effect estimate. A rating of 'very low' quality implies that any estimate of effect obtained is very uncertain.

The GRADE approach rates evidence from RCTs without serious limitations as high quality. However, several factors can lead to the downgrading of the evidence to moderate, low or very low. The degree of downgrading is determined by the seriousness of each of these factors:

- study limitations (risk of bias)
- inconsistency
- indirectness of evidence
- imprecision
- publication bias

We included a 'Summary of findings' table (Summary of findings for the main comparison) constructed according to the recommendations described in Chapter 10 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Handbook 2011). We used the GRADE considerations to assess the quality of the evidence for each outcome and to draw conclusions about the quality of evidence in the review. We included six outcomes in the 'Summary of findings' table: pain on postoperative days 1, 3 and 7, intraoperative blood loss, primary bleeding and secondary bleeding.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification.

Results of the search

We identified 1238 records by database searching through April 2017. The Information Specialist removed duplicates leaving 577 records for screening. We reviewed titles and abstracts and discarded 525 records, leaving 52 manuscripts for full-text review. Based on review of the complete manuscripts, we formally excluded 26 studies (27 references) (Excluded studies). Two studies are unclassified pending information from the authors (Nithya 2016; Trotter 2003). Six records represented additional references to previously evaluated studies included in the review. We included an additional 20 new studies (21 references) to the nine included studies in the previous version of this review (Burton 2007). The remaining two additional references related to one of the previously included studies (Philpott 2005). Parker 2009 was listed as an ongoing study in the prior version of this review. It has since been completed and is included in this update. This current review therefore includes a total of 29 studies.

A PRISMA flow chart depicting the process of screening and selecting studies can be found in Figure 1.

Figure 1. Process for sifting search results and selecting studies for inclusion.

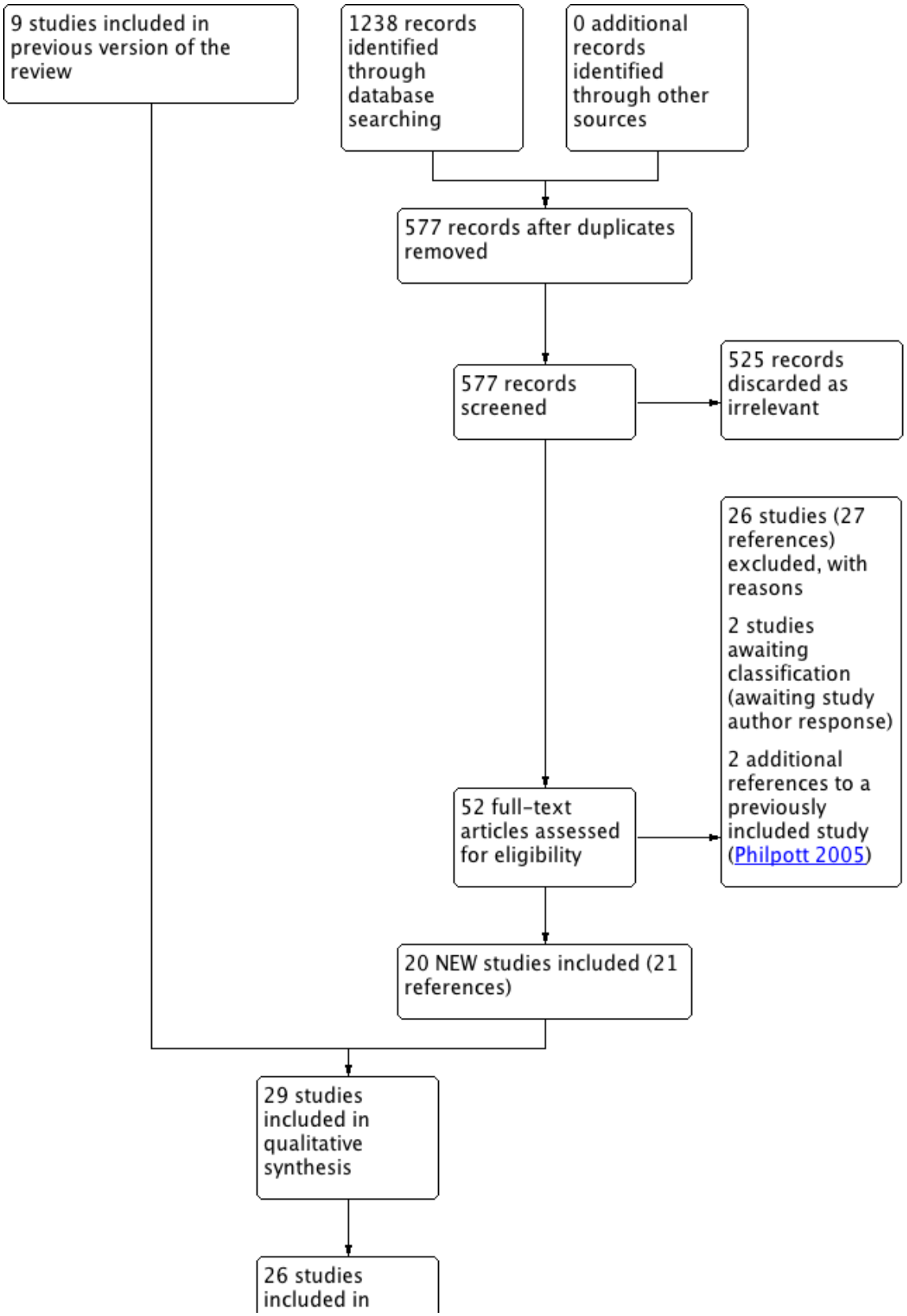
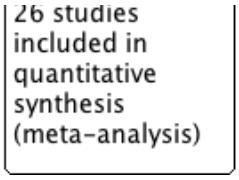


Figure 1. (Continued)



Most studies lacked sufficient details to permit full assessment of risk of bias and did not provide suitable and sufficient data for meta-analysis. We attempted to contact study authors for clarification. We obtained additional data from six studies (Elbadawey 2015; Gustavii 2010; Omrani 2012; Philpott 2005; Shah 2002; Shapiro 2007).

Included studies

Details of study design, sample size, participants, methods, interventions and outcomes are provided in the Characteristics of included studies table.

Design

All studies were parallel design, single-blinded randomised controlled trials.

Sample sizes

Sample sizes ranged from 34 to 274 participants (Anthony 2006; Shah 2002).

Participants

Indication

Most of the 29 studies included participants undergoing surgery for tonsillitis (infection), tonsillar hypertrophy (obstruction) or both. In seven studies the indication for surgery was not reported (Jayasinghe 2005; Kim 2013a; Matin 2013; Parker 2009; Parsons 2006; Shapiro 2007; Wang 2009).

Age

The studies could be broadly categorised as follows:

- Six studies included **adults and children** (Anthony 2006; Gustavii 2010; Kim 2013a; Parsons 2006; Wang 2005; Zhong 2006).
- Seven studies included **adults only** (Bäck 2001; Guo 2012; Hasan 2008; Hong 2013; Jayasinghe 2005; Philpott 2005; Tan 2006).
- Sixteen studies included **children (and adolescents) only** (D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Matin 2013; Mitic 2007; Omrani 2012; Paramasivan 2012; Parker 2009; Roje 2009; Roje 2011; Shah 2002; Shapiro 2007; Stoker 2004; Tan 2006; Wang 2009; Wang 2010).

Studies that enrolled adults and children did not always provide a detailed age distribution. Adult age was defined differently across studies. No study reported enrolling children younger than two years.

Interventions and comparisons

In all 29 studies coblation tonsillectomy was performed using equipment manufactured by ArthroCare Corporation, as judged by the terms and descriptions provided by the study authors. The technique of tonsillectomy in the control groups varied between studies and within some individual studies different techniques were used for tonsil excision and haemostasis. We broadly classified comparison techniques as either 'cold' or 'hot'. We included in the 'cold' comparison techniques studies of traditional surgical dissection ('cold steel') followed by diathermy for haemostasis.

In most studies it was unclear whether or not concurrent adenoidectomy was performed. This important information was lacking from studies that enrolled patients with tonsillar hypertrophy or obstructive symptoms - reasons for which patients might commonly undergo concurrent adenoidectomy with tonsillectomy.

- Adenoidectomy was performed in conjunction with tonsillectomy in at least some of the patients in nine studies (D'Eredità 2010; Mitic 2007; Parker 2009; Paramasivan 2012; Parsons 2006; Shah 2002; Shapiro 2007; Stoker 2004; Wang 2010).
- Two studies stated explicitly that no patients underwent adenoidectomy (D'Eredità 2009; Elbadawey 2015).
- Eighteen studies were 'unclear' about adenoidectomy (Anthony 2006; Bäck 2001; Guo 2012; Gustavii 2010; Hasan 2008; Hong 2013; Jayasinghe 2005; Kim 2013a; Matin 2013; Omrani 2012; Philpott 2005; Roje 2009; Roje 2011; Tan 2006; Temple 2001; Wang 2005; Wang 2009; Zhong 2006).

Outcomes

Postoperative pain and return to normal diet and activity were reported in patient or parent diaries, or collected by study personnel interview. For reporting postoperative outcomes we considered postoperative day 0 to be the day of surgery. We adjusted the data for the two studies that did not adhere to this convention (Matin 2013; Paramasivan 2012).

Primary outcomes

Pain

Many studies in this review used previously validated pain scales including the Wong Baker FACES scale (D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Paramasivan 2012; Parsons 2006; Shapiro 2007; Stoker 2004; Wang 2009), and visual analogue scales (VAS) (Anthony 2006; Bäck 2001; Gustavii 2010; Hasan 2008; Hong 2013; Jayasinghe 2005; Kim 2013a; Matin 2013; Mitic 2007; Omrani 2012; Philpott 2005; Tan 2006; Temple 2001; Zhong 2006). However, most studies adapted or implemented the scales in a manner that *may* have invalidated them. For example, many studies changed the numeric reference points for the Wong Baker FACES scale to 0 to 5 rather than 0 to 10 (D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Paramasivan 2012; Parsons 2006; Shapiro 2007; Stoker 2004; Wang 2009). Similarly, many studies that used a VAS changed the anchor points to 0 to 4, 0 to 6 or 1 to 5 rather than 0 to 100 (Anthony

2006; Hong 2013; Jayasinghe 2005; Kim 2013a; Matin 2013; Mitic 2007; Tan 2006; Temple 2001). Perhaps of greatest concern is that although the VAS has not been validated in children, many studies used it to assess pain in children as young as three or four years old (Anthony 2006; Gustavii 2010; Kim 2013a; Matin 2013; Mitic 2007; Omrani 2012; Temple 2001; Zhong 2006).

In our protocol we stated that we would compare pain using validated pain scales only. However, we chose to include in the meta-analysis studies that measured pain using a scale that was largely based on a validated pain scale. Thus we included studies that used a VAS regardless of anchor points and we used studies using the Wong Baker FACES scale regardless of the numbers assigned to the scale.

Some studies collected data with a validated scale but reported the data in a manner that precluded meta-analysis, such as collecting continuous data but reporting it categorically, reporting data without a mean or variance estimate, or reporting an aggregate pain rating over several days.

Intraoperative bleeding

Elbadawey 2015 and Matin 2013 measured blood loss by sponge weight and volume of aspirated blood. Elbadawey 2015 further specified that they used a paediatric suction canister. In the remainder of the studies, the method of determining intraoperative blood loss was poorly described. Hong 2013 counted sponges, Paramasivan 2012 weighed sponges and five studies either estimated or measured aspirated blood volume (Bäck 2001; D'Eredità 2009; D'Eredità 2010; Omrani 2012; Roje 2009). Thirteen studies did not describe the method used to determine blood loss (Guo 2012; Hasan 2008; Jayasinghe 2005; Mitic 2007; Parsons 2006; Roje 2011; Shah 2002; Shapiro 2007; Stoker 2004; Wang 2005; Wang 2009; Wang 2010; Zhong 2006).

Two important sources of uncertainty impacted nearly all of the studies. First, saline irrigation is necessary for coblation technology and the volume of saline irrigant confounds measurement of intraoperative blood loss, yet only two studies reported subtracting the volume of saline irrigant from the total volume of aspirate in the suction canister (D'Eredità 2010; Paramasivan 2012). Second, in children undergoing adenoidectomy as well as tonsillectomy some blood loss is related to the former procedure and most studies provided no indication as to whether the blood loss from tonsillectomy was measured separately from that from the adenoidectomy. However, when randomisation is adequate, both groups within a study should include a similar proportion of patients with concurrent adenoidectomy and the additional blood loss from the adenoidectomy would be balanced between the two groups.

This uncertainty means that the outcome reflects an estimate of the collection of various intraoperative fluids rather than a precise measure of blood loss.

Adverse effects: the incidence of primary (within 24 hours of surgery) and secondary (> 24 hours postoperatively) bleeding

Postoperative bleeding following tonsillectomy comes from the tonsillar fossae. The amount of bleeding can range from a pink tinge to the oral secretions to major bleeding. Most studies in this review followed the standard convention of timing for primary and secondary bleeding and we report both of these outcomes separately. Three studies in this review did not distinguish between primary and secondary bleeding (Guo 2012; Parker 2009; Roje 2011).

Secondary outcomes

Time until resumption of normal diet in days

Fourteen studies measured this outcome (Anthony 2006; Elbadawey 2015; Hong 2013; Matin 2013; Omrani 2012; Parker 2009; Parsons 2006; Philpott 2005; Shapiro 2007; Stoker 2004; Tan 2006; Temple 2001; Wang 2009; Zhong 2006). Parker 2009 reported return to drinking separately from return to solid food; we considered the return to solid food intake to be an indication of normal diet. Two additional studies reported outcomes related to postoperative food intake using a different measure (Shah 2002 ordinal diet score; Wang 2010 time to first food intake) and two studies stated that this outcome was collected but did not report the results (D'Eredità 2010; Mitic 2007).

Time until resumption of normal activity in days

Thirteen studies measured this outcome (Bäck 2001; D'Eredità 2010; Hasan 2008; Omrani 2012; Parsons 2006; Philpott 2005; Roje 2009; Roje 2011; Shapiro 2007; Stoker 2004; Tan 2006; Wang 2009; Zhong 2006). Two additional studies reported outcomes related to resumption of normal activity using a different measure (Shah 2002 ordinal activity score; Mitic 2007 averaged scores from parents and nurses). One study stated that this outcome was collected but did not report the results (D'Eredità 2010).

Duration of surgery (minutes)

Eighteen studies measured this outcome (Bäck 2001; Elbadawey 2015; Guo 2012; Hasan 2008; Hong 2013; Jayasinghe 2005; Kim 2013a; Matin 2013; Mitic 2007; Omrani 2012; Paramasivan 2012; Parsons 2006; Shah 2002; Shapiro 2007; Stoker 2004; Wang 2005; Wang 2009; Wang 2010). The activities included in this measurement varied across studies and were poorly described. Two important sources of uncertainty impact nearly all of the studies. First, many reports were unclear as to whether or not the duration of surgery included anaesthetic induction and emergence from anaesthesia or only the surgical procedure time. Second, it was unclear whether the time for adenoidectomy was included in the measure of duration of surgery. However, provided randomisation was adequate, both groups within a study should include a similar proportion of patients undergoing adenoidectomy, resulting in a non-differential bias with additional adenoidectomy time balanced among the groups.

Adverse effects: e.g. postoperative infection, the need for reoperation

Of the 25 studies that reported postoperative bleeding, 19 also reported how bleeding was managed, including 21 patients who required operative management and two patients who required blood transfusion. Six studies did not report how episodes of postoperative bleeding were managed (Anthony 2006; Guo 2012; Kim 2013a; Omrani 2012; Parker 2009; Roje 2011).

Five studies reported additional adverse events, most of which are not unexpected following tosillectomy (D'Eredità 2010; Gustavii 2010; Jayasinghe 2005; Shah 2002; Stoker 2004). Mortality was not listed as an outcome for any of the studies and no deaths were reported.

Excluded studies

A summary and details of the excluded studies can be found in the Characteristics of excluded studies table. Four studies performed intracapsular tonsillectomy, five studies were not randomised controlled trials (including two retrospective studies (Glade 2006; Walner 2012)), and two studies determined treatment group according to surgical facility (Parker 2011) or surgeon (Patel 2004). Eight studies randomised tonsils instead of patients, allowing patients to act as their own controls. We excluded these studies (Fawzy 2012; Hall 2004; Littlefield 2002; Littlefield 2005; Noordzij 2006; Polites 2006; Saengpanich 2005; Timms 2002).

The study Patel 2004 is described in a conference abstract (the only published record of this study) as a "double-blind randomised controlled trial" and it included 300 patients. We sought further information from the senior author (Rachmanidou); she confirmed that randomisation for this study was "not formal", as patients on one consultant's waiting list were operated on using coblation, whilst patients under the care of other consultants were operated on using cold dissection or bipolar diathermy. She also confirmed that the study was not blinded. We therefore concluded that this was not a randomised controlled trial and excluded it from the review.

Metcalfe 2017 is a systematic review of coblation tonsillectomy. However, Metcalfe defined coblation broadly, including studies of bipolar radiofrequency without plasma-mediated ablation. In this review we define coblation as bipolar frequency plasma-mediated ablation. Thus several studies in the Metcalfe review do not meet the inclusion criteria for this review.

The study Roje 2004 is listed as a conference abstract but there is no corresponding publication. We were unable to obtain a copy of the abstract and we did not receive a response from the author (Z Roje).

Risk of bias in included studies

A summary and details of the 'Risk of bias' assessment can be found in the Characteristics of included studies table. A 'Risk of bias' summary (our judgements about each risk of bias item for each included study) is shown in Figure 2. A 'Risk of bias' graph (our judgements about each risk of bias item presented as percentages across all included studies) is shown in Figure 3.

Figure 2. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study.

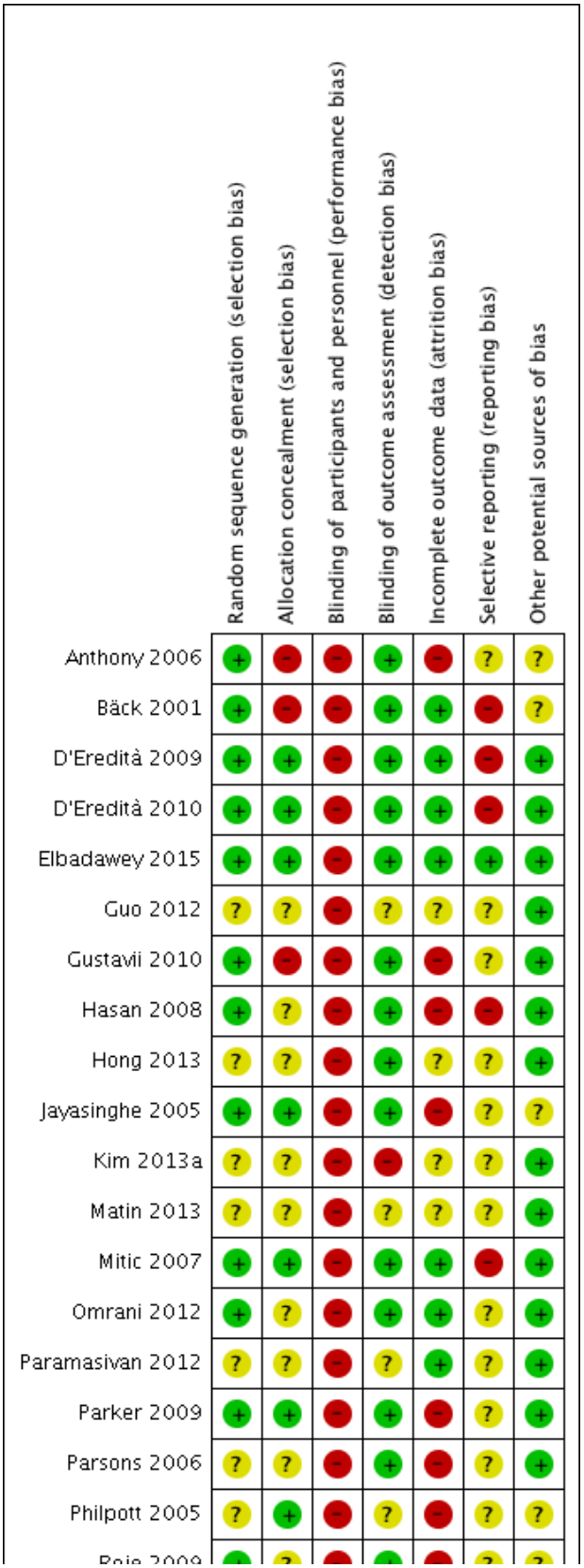


Figure 2. (Continued)

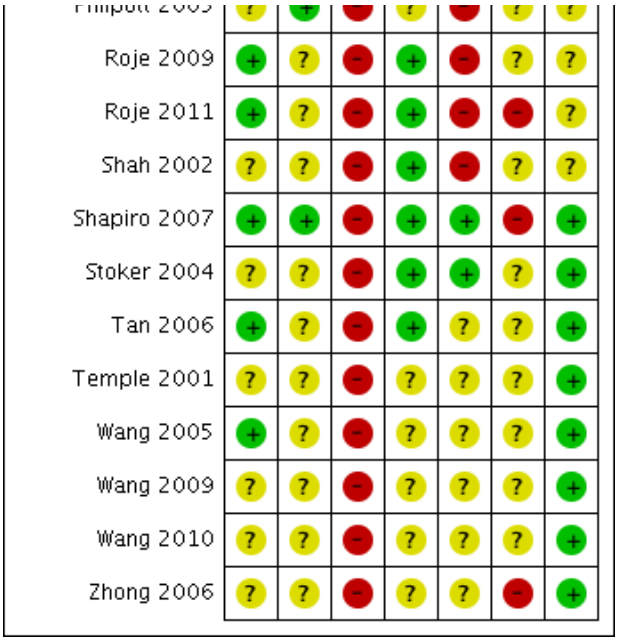
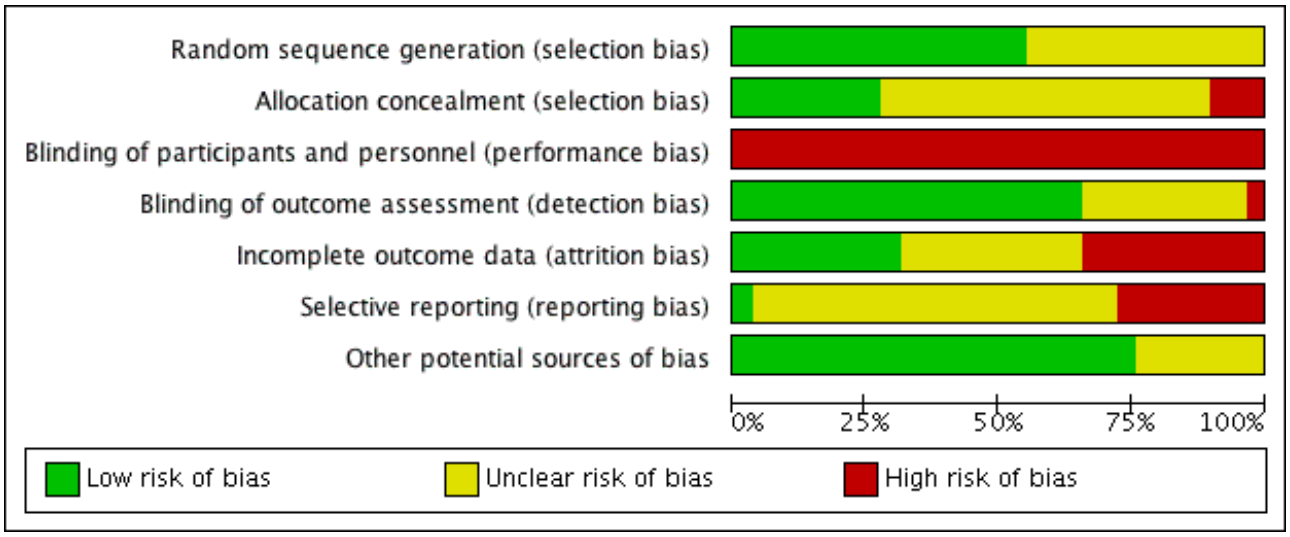


Figure 3. 'Risk of bias' graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



For those instances where the reports did not describe the methodology adequately (e.g. in study abstracts), we attempted to obtain clarification from the authors of the studies. If clarification was obtained, we used that new information to assign the risk of bias for that domain. Remaining uncertainty is noted with an 'unclear' risk of bias.

The original version of this review contained two unpublished studies (Anthony 2006; Jayasinghe 2005). Information about Anthony 2006 had been obtained from two of the study authors, GJC Smelt and H Wallace. This information included an unpublished manuscript and patient level data. Information about Jayasinghe 2005 had been obtained from one of the study authors. This information included an emailed electronic presentation and aggregated summary patient data by group.

Allocation

Sequence generation

We rated 16 studies as having a low risk of bias for random sequence generation (Anthony 2006; Bäck 2001; D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Gustavii 2010; Hasan 2008; Jayasinghe 2005; Mitic 2007; Omrani 2012; Parker 2009; Roje 2009; Roje 2011; Shapiro 2007; Tan 2006; Wang 2005). The remaining 13 studies did not adequately describe the method of randomisation and are thus considered to have an unclear risk of selection bias (Guo 2012; Hong 2013; Kim 2013a; Matin 2013; Paramasivan 2012; Parsons 2006;

Philpott 2005; Shah 2002; Stoker 2004; Temple 2001; Wang 2009; Wang 2010; Zhong 2006).

Allocation concealment

The method of allocation concealment was sufficiently described in eight studies to permit rating them as low risk of bias (D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Jayasinghe 2005; Mitic 2007; Parker 2009; Philpott 2005; Shapiro 2007). We rated three studies as having a high risk of bias for this domain (Anthony 2006; Bäck 2001; Gustavii 2010). We deemed the remaining 18 studies to have an unclear risk of bias for allocation concealment (Guo 2012; Hasan 2008; Hong 2013; Kim 2013a; Matin 2013; Omrani 2012; Paramasivan 2012; Parsons 2006; Roje 2009; Roje 2011; Shah 2002; Stoker 2004; Tan 2006; Temple 2001; Wang 2005; Wang 2009; Wang 2010; Zhong 2006).

Blinding

We assigned an overall risk of performance bias and detection bias for each study based on this review's primary outcomes. The inability to blind operative personnel would not be expected to cause detection bias for pain (a patient-reported outcome) but may cause detection bias for intraoperative blood loss, and primary and secondary bleeding.

Personnel

Many studies reported that all procedures in both groups were performed by a single surgeon. We carefully considered whether a surgeon's attitude toward coblation might bias performance, particularly if the surgeon performs the procedures in both groups. No study described any steps taken to mitigate against possible surgeon bias, such as randomising patients to treatment groups wherein all of the procedures in the coblation group are performed by a surgeon who is a proponent of coblation and all of the procedures in the comparator group are performed by a similarly experienced surgeon who is a proponent of the comparator technique. Many studies also did not report whether steps were taken to blind the postoperative patient care team. For these reasons, performance bias is high for all outcomes across all studies. Detection bias is necessarily high for outcomes assessed by surgical personnel (primary and secondary bleeding, intraoperative blood loss and duration of surgery). However, provided the patients were blinded, detection bias is low for patient-reported outcomes (pain, return to normal diet and activity).

Patients

Of the 26 studies that reported postoperative pain, we rated 16 as having a low risk of detection bias (Anthony 2006; Bäck 2001; D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Gustavii 2010; Hasan 2008; Hong 2013; Jayasinghe 2005; Mitic 2007; Omrani 2012; Parker 2009; Parsons 2006; Shapiro 2007; Stoker 2004; Tan 2006), and we rated 10 of them as having an unclear risk of detection bias (Guo 2012; Kim 2013a; Matin 2013; Paramasivan 2012; Philpott 2005; Temple 2001; Wang 2005; Wang 2009; Wang 2010; Zhong 2006). Of the 16 studies that reported return to normal diet, we rated 11 as having a low risk of detection bias (Anthony 2006; Elbadawey 2015; Hasan 2008; Hong 2013; Mitic 2007; Omrani 2012; Parker 2009; Parsons 2006; Shah 2002; Shapiro 2007; Tan 2006), and five as having an unclear risk of detection bias (Matin 2013; Philpott 2005; Temple 2001; Wang 2009; Zhong 2006). Of the 13 studies that reported return to normal activity, we rated nine as having a low risk of detection bias (Bäck 2001; Omrani 2012; Parsons 2006; Roje 2009; Roje 2011; Shah 2002; Shapiro 2007; Stoker 2004; Tan 2006), and four as having an unclear risk of detection bias (Hasan 2008; Philpott 2005; Wang 2009; Zhong 2006).

Incomplete outcome data

We considered 10 studies to have a high risk of attrition bias, including eight studies with an attrition rate greater than 10% (Anthony 2006; Gustavii 2010; Jayasinghe 2005; Parker 2009; Parsons 2006; Philpott 2005; Roje 2009; Shah 2002), and three studies that excluded a subset of patients from analysis (Hasan 2008; Parker 2009; Roje 2011). One study was terminated early due to a high rate of secondary bleeding (Shah 2002). We rated 10 studies as having an unclear risk of bias either because they did not report attrition rates (Guo 2012; Hong 2013; Kim 2013a; Matin 2013; Temple 2001; Wang 2005; Wang 2009; Wang 2010; Zhong 2006), or because there was insufficient detail to determine whether the modest attrition might have biased the study (Tan 2006). We rated nine studies as having low risk of attrition bias (Bäck 2001; D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Mitic 2007; Omrani 2012; Paramasivan 2012; Shapiro 2007; Stoker 2004).

Selective reporting

There were no protocols available for any of the studies to permit comparison between planned outcomes and reported outcomes. Therefore, we judged all studies as having an unclear risk of reporting bias, unless there were specific reasons to consider these to be at high risk of bias. If studies failed to report results for outcomes that were stated in the methods section of their publications, we rated these as high risk of bias. For example, Mitic 2007 and D'Eredità 2010 collected return to normal diet data but did not report the results and D'Eredità 2010 collected return to normal activity data but did not report the results. We also assigned the risk as high if the studies reported key results in a way that did not allow further analysis. We considered eight studies to be at high risk of reporting bias (Bäck 2001; D'Eredità 2009; D'Eredità 2010; Hasan 2008; Mitic 2007; Roje 2011; Shapiro 2007; Zhong 2006).

Other potential sources of bias

Sources of potential bias that are not included in other domains include early termination of the study, sponsorship by a device manufacturer, lack of clarity in describing the number of patients in groups, lack of publication and unexpectedly high rates of complications. There were two studies with rates of postoperative bleeding that were so much higher than the generally expected rate of bleeding in both the coblation and the comparison groups that we thought this signalled a potential problem (Bäck 2001; Philpott 2005). Intraoperative bleeding in the coblation group was statistically significantly higher than in the cold dissection group in one study (Bäck 2001).

Conflict of interest is an important potential source of bias that was difficult to assess. One study stated that was supported by a grant from the ArthroCare Corporation (manufacturer of the coblation device) (Stoker 2004). Three other studies thanked the device manufacturer for donation of the coblation handpieces (Shah 2002; Shapiro 2007; Temple 2001). However, most of the remaining studies were silent on this topic, as only three studies had explicit statements regarding any conflicts of interests of the investigators: all three stated that the study investigators had no

conflicts to disclose (Mitic 2007; Parker 2009; Roje 2011). These aspects of potential bias are reported in the Characteristics of included studies table.

Many of the included studies did not clearly describe patient flow through the clinical study and it was difficult to distinguish among eligible patients, enrolled patients, randomised patients, treated patients, excluded patients and patients who were lost to follow-up. Again, these numbers are detailed in the Characteristics of included studies table. One study was terminated early due to airway complications that occurred in the experimental group, thus planned enrollment numbers were not reached (Shah 2002).

We included two unpublished studies in this review (Anthony 2006; Jayasinghe 2005). We were able to obtain study data for both of these studies from the respective authors.

Effects of interventions

See: **Summary of findings for the main comparison** Coblation versus other surgical techniques for tonsillectomy

See Summary of findings for the main comparison for the main comparison.

A variety of data reporting problems precluded us from including studies in the meta-analyses. Most studies did not provide any information related to the variance (e.g. standard deviations) for continuous outcomes such as pain or intraoperative blood loss. Many studies reported data graphically without accompanying numerical data, although when possible we interpreted means and standard deviations from the graphs. Other studies reported no data at all - no mean values, no variance estimates and no P values - and only reported that a finding either was or was not statistically significant. Some studies reported results without indicating whether they had used parametric or non-parametric tests. It is possible that studies with favourable results were more likely to provide detailed data and it is possible that selective reporting occurred. For this reason, we downgraded the quality of evidence for all outcomes in which less than half of the studies could be included in the meta-analysis.

Although we included 29 studies in the review, most did not report data in a way that allowed for meta-analysis. When possible, we pooled data and conducted the planned subgroup analyses. For those outcomes in which less than half of the studies contributed data to the pooled meta-analysis, we also qualitatively reviewed the direction of effects obtained from the meta-analysis with the direction of effects in studies that had to be excluded from the meta-analysis due insufficient information.

Although we had planned to conduct three types of subgroup analyses (Subgroup analysis and investigation of heterogeneity), we have only displayed the subgroup analysis by type of surgical technique used in the control group (cold versus hot techniques) and we could only carry out proper subgroup analysis for three outcomes: primary bleeding, secondary bleeding and duration of surgery. There were more studies reporting these outcomes, which are more easily reported in a consistent manner across studies (number of patients who had an event for bleeding, or minutes of time for duration of surgery). In contrast, other outcomes had many variations and limitations in the measurement and reporting methods used, resulting in very few data that could ultimately be included in the meta-analysis.

The other two planned subgroup analyses based on type of surgery (tonsillectomy only versus adenoidectomy and tonsillectomy) and patient age (children versus adults) could not be conducted in a meaningful way (there were too few data and none showed statistical significance in the test of subgroup differences). Many studies did not report data in a manner that permitted allocation of patients into these subgroups.

We did not carry out planned sensitivity analyses based on risk of bias because for all outcomes the majority of the studies had either an unclear or high risk of bias, and there would have been insufficient studies with low risk of bias to constitute a meaningful sensitivity analysis.

Primary outcome (a) Pain as reported by patient

Pain was reported using linear (visual analogue scale - VAS) and ordinal (Wong Baker FACES) scales and we analysed these with the standardised mean difference (SMD). Due to the high heterogeneity we used a random-effects model. We also considered whether to pool the data in the face of unresolved heterogeneity. Ultimately, we chose to do so because pain is a primary outcome.

Postoperative pain, postoperative day 1

Six studies contributed data to this meta-analysis, including one study that used hot tonsillectomy as a comparator and six studies that used cold tonsillectomy as a comparator (one study had both the cold and hot technique comparison groups (Elbadawey 2015). On postoperative day 1 the level of pain was lower in the coblation group (SMD -0.79, 95% confidence interval (CI) -1.38 to -0.19; 538 participants; six studies; I^2 = 90%) (Analysis 1.1). There were too few studies available to conduct the planned subgrouped investigations for high statistical heterogeneity.

One study had effect sizes that were larger than the others (Wang 2009). We could not find any specific reasons to exclude the results of this study and therefore we investigated the impact of this study on the overall pooled effect size. When we excluded this study from the meta-analysis the effect size was smaller (SMD -0.48, 95% CI -0.79 to -0.17; 446 participants; five studies; I^2 = 60%). The statistical heterogeneity remained substantial.

Postoperative pain, postoperative day 3

Five studies contributed data to this meta-analysis and all of these were studies that used cold tonsillectomy as a comparator. No hot dissection studies contributed data to this outcome in the meta-analysis. On postoperative day 3 there was no statistically significant difference in the level of pain between the coblation group and the comparison group (SMD -0.44, 95% CI -0.97 to 0.09; 401 participants; five studies; I^2 = 85%) (Analysis 1.2). There were too few studies available to conduct the planned subgrouped investigations for high statistical heterogeneity.

As with the analysis for postoperative pain day 1, excluding Wang 2009 reduced the effect size (SMD -0.21, 95% CI -0.54 to 0.12; 309 participants; four studies; I^2 = 52%), but the statistical heterogeneity remained substantial.

Postoperative pain, postoperative day 7

Five studies contributed data to this meta-analysis. One study that reported pain on postoperative day 3 did not report pain on postoperative day 7 (Paramasivan 2012), and an additional study

that did not report pain on postoperative day 3 did report pain on postoperative day 7 (Elbadawey 2015). On postoperative day 7 the SMD was -0.01 (95% CI -0.22 to 0.19; 420 participants; five studies; I^2 = 9%) (Analysis 1.3). There was no statistically significant difference in the level of pain between the coblation group and the hot technique group (SMD -0.43, 95% CI -0.97 to 0.11), nor between the coblation group and the cold technique group (SMD 0.05, 95% CI -0.16 to 0.26). There were too few studies available to conduct the planned subgroup investigations for high statistical heterogeneity.

Among the 20 studies that could not be meta-analysed the results varied. Some studies found no statistically significant difference between coblation and the comparator technique; other studies found some benefit for coblation. Among the studies that reported at least some possible benefit for coblation, limitations in data reporting prevented us from determining how that difference in pain would have been experienced by the patient. For example, some studies compared pain on a daily basis, as we have done in this review. Other studies reported an aggregate pain score for the entire postoperative time period, and still others reported the number of days to resolution of pain (Guo 2012; Parker 2009). Finally, most studies did not clarify whether a statistically significant difference would have been clinically significant.

It is difficult to interpret whether the observed effect estimates for postoperative day 1 and postoperative day 3 were of clinical significance. While it is commonly accepted that the minimal clinically important difference for chronic pain is a SMD of 0.5, the values are less well established for acute pain, particularly for post-surgical pain. We estimated that the observed differences on postoperative day 1 (a SMD of 0.79) are equivalent to about an 11 mm difference on a VAS (1 mm to 100 mm). However, some studies in emergency acute pain (non-surgical) suggest that the minimal clinically important difference on a VAS is 13 mm to 16 mm (Bijur 2001; DeLoach 1998; Gallagher 2002). Thus, it is unclear whether the lower pain scores on postoperative day 1 and postoperative day 3 were of clinical importance. Moreover, there is very high uncertainty in this estimate based on the wide confidence intervals. We consider the quality of this evidence to be *very low* because of very serious limitations in study methodology including possible reporting biases, statistical heterogeneity, imprecision of the evidence based on the wide confidence intervals and publication bias based on the small proportion of studies that reported data in a manner that permitted meta-analysis. More importantly, there is a severe limitation in terms of uncertainty as to whether many of these studies used appropriately validated instruments to measure the pain outcome.

Primary outcome (b) Intraoperative blood loss

Twenty studies reported data, but only nine reported sufficient information for possible meta-analysis (Elbadawey 2015; Jayasinghe 2005; Omrani 2012; Parsons 2006; Roje 2009; Shah 2002; Wang 2005; Wang 2009; Wang 2010). However, due to extreme statistical heterogeneity (I^2 = 95%) we did not pool data in a meta-analysis (Analysis 1.4). Only Elbadawey 2015 was explicitly limited to tonsillectomy. None of the studies that performed adenotonsillectomy reported tonsillectomy and adenoidectomy blood loss separately and none of the studies subtracted the saline irrigant from the reported blood loss.

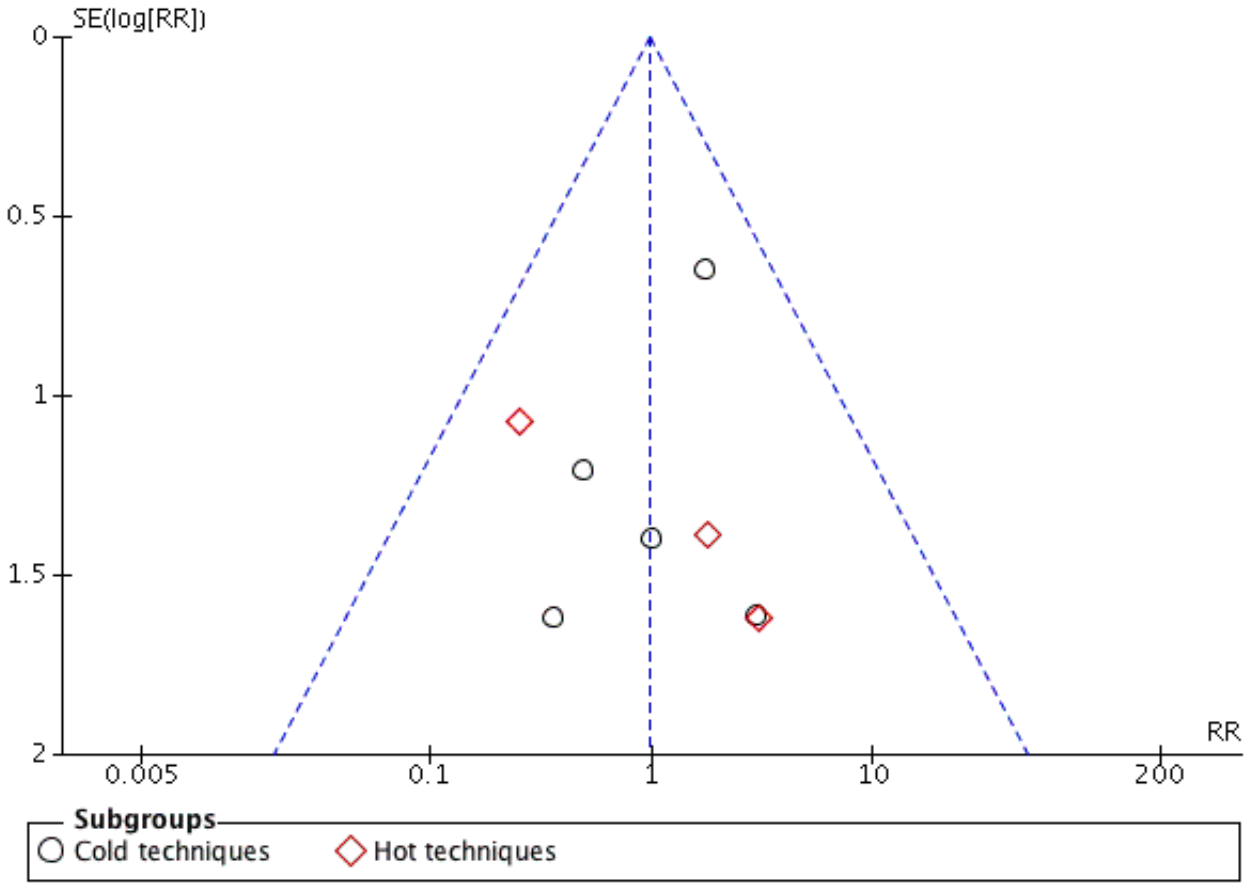
We consider the evidence for this outcome to be of *very low quality* due to very serious limitations in study methodology (risk of bias for sequence generation, allocation concealment, performance bias and detection bias), extreme statistical heterogeneity that precluded meta-analysis and publication bias, with few studies that reported data necessary for meta-analysis.

Primary outcome (c) Primary postoperative bleeding, within 24 hours of surgery

For this analysis, we used the risk ratio and a fixed-effect model due to the low number of events. Twenty-five studies contributed data to the meta-analysis of primary bleeding (Bäck 2001; Elbadawey 2015; D'Eredità 2009; D'Eredità 2010; Guo 2012; Gustavii 2010; Hasan 2008; Hong 2013; Jayasinghe 2005; Matin 2013; Mitic 2007; Omrani 2012; Paramasivan 2012; Parsons 2006; Philpott 2005; Roje 2009; Shah 2002; Shapiro 2007; Stoker 2004; Tan 2006; Temple 2001; Wang 2005; Wang 2009; Wang 2010; Zhong 2006). The overall pooled result was RR 0.99 (95% CI 0.48 to 2.05; 2055 participants; 25 studies; I^2 = 0%) (Analysis 1.5). No significant subgroup effects were detected in the comparison against cold techniques (RR 1.16, 95% CI 0.47 to 2.85; 1207 participants; 15 studies; I^2 = 0%) or in the comparison against hot techniques (RR 0.73, 95% CI 0.20 to 2.60; 848 participants; 11 studies; I^2 = 9%).

We consider the evidence for this outcome to be of *low quality* because of very serious limitations in study methodology (risk of bias for sequence generation, allocation concealment, performance bias and detection bias) and imprecision of the evidence based on the wide confidence intervals. We detected no asymmetry in the funnel plot (Figure 4) (Horbold-Egger bias 0.25, 92.5% CI -1.66 to 2.17; P = 0.79).

Figure 4. Funnel plot of comparison: 1 Coblation versus alternative tonsillectomy techniques, outcome: 1.5 Primary bleeding.

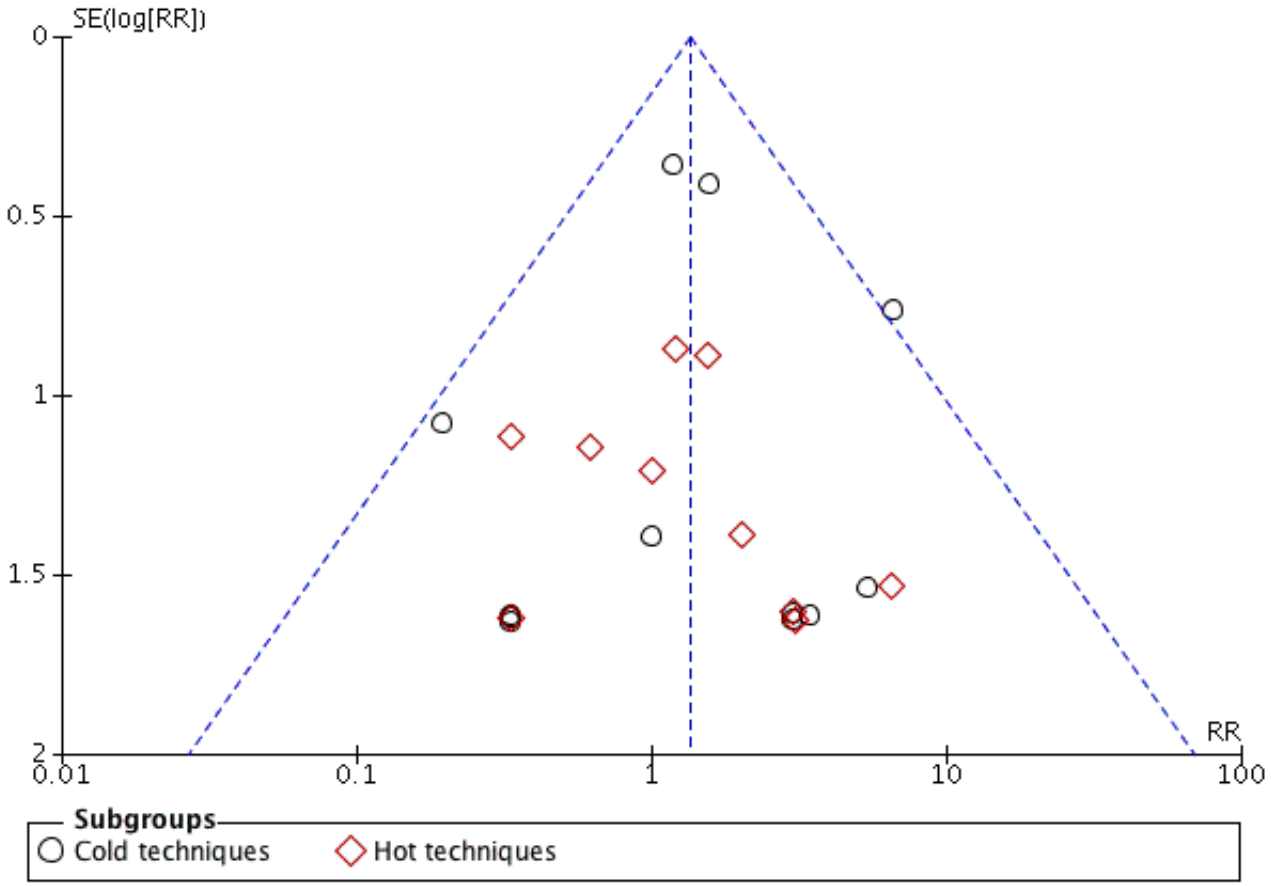


Primary outcome (d) Secondary postoperative bleeding, more than 24 hours after surgery

For this analysis, we used the risk ratio and a fixed-effect model due to the low number of events. Twenty-five studies contributed data to the meta-analysis of secondary bleeding (Anthony 2006; Bäck 2001; D'Eredità 2009; D'Eredità 2010; Elbadawey 2015; Guo 2012; Gustavii 2010; Hasan 2008; Hong 2013; Jayasinghe 2005; Matin 2013; Mitic 2007; Omrani 2012; Parsons 2006; Philpott 2005; Roje 2009; Shah 2002; Shapiro 2007; Stoker 2004; Tan 2006; Temple 2001; Wang 2005; Wang 2009; Wang 2010; Zhong 2006).

There was a greater risk of secondary bleeding with coblation that was nearly statistically significant (RR 1.36, 95% CI 0.95 to 1.95; 2118 participants; 25 studies; I^2 = 0%) (Analysis 1.6). Tests for subgroup differences found no statistically significant difference based on the surgical technique used in the control group. We consider the evidence for this outcome to be of *low quality* because of very serious limitations in study methodology (risk of bias for sequence generation, allocation concealment, performance bias and detection bias) and imprecision of the evidence based on the wide confidence intervals. A funnel plot demonstrates a balance of publications based on study size and effect size (Figure 5). We detected no asymmetry in the funnel plot (Horbold-Egger bias -0.03, 92.5% CI -0.90 to 0.83; P = 0.94).

Figure 5. Funnel plot of comparison: 1 Coblation versus alternative tonsillectomy techniques, outcome: 1.6 Secondary bleeding.



Secondary outcome (a) Time until resumption of normal diet (days)

Data from five studies were eligible for inclusion in a potential meta-analysis (Omrani 2012; Philpott 2005; Stoker 2004; Tan 2006; Zhong 2006). However, due to extreme statistical heterogeneity (I^2 = 95%) we did not pool the data (Analysis 1.7). Among the 11 studies that did not contribute data for meta-analysis, seven reported results indicating no statistically significant difference in return to normal diet between coblation and other surgical techniques.

We consider the evidence for this outcome to be of *very low quality* due to very serious limitations in study methodology (risk of bias for sequence generation, allocation concealment, performance bias and attrition bias), extreme statistical heterogeneity that precluded meta-analysis, reporting bias (Mitic 2007 and D'Eredità 2010 collected but did not report this outcome) and publication bias, with few studies that reported data necessary for meta-analysis.

Secondary outcome (b) Time until resumption of normal activities (days)

Only four studies contributed data for a possible meta-analysis (Omrani 2012; Philpott 2005; Stoker 2004; Tan 2006). However, due to extreme statistical heterogeneity (I^2 = 97%) we did not pool the data (Analysis 1.8). Among the 10 studies that were not eligible for meta-analysis, there was considerable heterogeneity in the results that made it impossible to determine whether there may be a difference between coblation and other surgical techniques in time to return to normal activities.

We consider the evidence for this outcome to be of *very low quality* due to very serious limitations in study methodology (risk of bias for sequence generation, allocation concealment, performance bias and attrition bias), extreme statistical heterogeneity that precluded meta-analysis, reporting bias (D'Eredità 2010 collected but did not report this outcome) and publication bias, with few studies that reported data necessary for meta-analysis.

Secondary outcome (c) Duration of surgery (minutes)

Eleven studies contributed data for a possible meta-analysis (Jayasinghe 2005; Kim 2013a; Omrani 2012; Parsons 2006; Shah 2002; Shapiro 2007; Stoker 2004; Wang 2005; Wang 2009; Wang 2010; Zhong 2006). However, due to extreme statistical heterogeneity (I^2 = 95%) we did not pool the data (Analysis 1.9). Among the seven studies that were unsuitable for meta-analysis the results were heterogeneous and it is not possible to determine whether there may be a difference between coblation and other surgical techniques in the duration of surgery.

We consider the evidence for this outcome to be of *very low quality* due to very serious limitations in study methodology (risk of bias

for sequence generation, allocation concealment, performance bias and detection bias) and extreme statistical heterogeneity that precluded meta-analysis.

Secondary outcome (d) Adverse effects

This outcome is designed to capture other adverse events that were not included as specific outcomes in the meta-analysis. Events captured by this measure include expected postoperative events, such as readmission for pain management and hydration, hospital admission following bleeding and blood transfusion following bleeding. The rate of events varied substantially across studies, possibly based on the rigour with which they were sought.

Of the 25 studies that reported at least one episode of postoperative bleeding, 19 (representing 1566 patients) also reported how the episodes of bleeding were managed. This included 21 patients who required operative management and two patients who required blood transfusion. Six studies (representing 506 patients) did not report how episodes of postoperative bleeding were managed (Anthony 2006; Guo 2012; Kim 2013a; Omrani 2012; Parker 2009; Roje 2011).

Five studies reported additional adverse events (D'Eredità 2010; Gustavii 2010; Jayasinghe 2005; Shah 2002; Stoker 2004). Vomiting, dehydration, ear pain and velopharyngeal insufficiency are expected following tonsillectomy and were reported in multiple studies. These types of events are common following tonsillectomy and, for this reason, it seems that the different rates of adverse events across studies appear to be largely due to the rigour with which adverse events were defined and collected. One study additionally catalogued minor adverse events including mouth odour, cough, lethargy, confusion and dizziness, drooling and poor speech quality, recurrent pharyngitis, uvular haematoma, need for intravenous antibiotics and/or narcotics (fever, pain, nausea), throat discomfort lasting more than three months, snoring and altered taste (Gustavii 2010).

Mortality was not listed as an a priori outcome in any of the studies and no deaths were reported.

DISCUSSION

Summary of main results

See Summary of findings for the main comparison.

In this review we found *very low-quality* evidence that coblation tonsillectomy may cause less pain on postoperative day 1 compared to other surgical techniques. However, the magnitude of the difference in pain is not clinically meaningful.

We also found *low-quality* evidence that secondary bleeding rates may be higher with coblation tonsillectomy, a finding that is consistent with the National Prospective Tonsillectomy Audit conducted in England and Northern Ireland (BAO-HNS/RCSENG 2005). The magnitude of the greater risk of secondary bleeding with coblation (risk ratio (RR) 1.36, 95% confidence interval (CI) 0.95 to 1.95; 2118 participants; 25 studies; $I^2 = 0\%$), in conjunction with the morbidity and potential mortality of secondary bleeding, make this a clinically meaningful difference.

Overall completeness and applicability of evidence

The studies in this review included relevant patient populations (children and adults undergoing surgery for infection or obstruction), although subgroup analyses were often not possible due to study design or data reporting. We included studies with all types of comparator technique for tonsillectomy, although some may debate the manner in which we categorised techniques as 'hot' or 'cold', particularly if the primary dissection technique was cold and haemostasis was performed with a hot technique.

The studies in this review directly evaluated outcomes important to patients and providers: postoperative pain, intraoperative blood loss and postoperative bleeding. Many studies also evaluated the impact of tonsillectomy on quality of life by measuring return to normal diet and activity. However, the studies in this review generally failed to collect and report these outcomes in a manner permitting meta-analysis. Although capturing charges from the physicians, operating and recovery rooms, and medical supplies was beyond the scope of the studies in this review, many studies measured duration of surgery and we used that measure as an imperfect proxy for cost. Unfortunately, the results were heterogeneous making it impossible to determine whether there may be a difference between coblation and other surgical techniques in the duration of surgery. In addition, not included in our proxy measure of cost is the additional cost of the coblation wand, which is a disposable handpiece, more expensive than a monopolar cautery handpiece. The data from the studies identified are of such uniformly low quality that we cannot conclude that one technique is favourable. This review is unable to compare the rate of primary and secondary haemorrhage as these are rare events and unlikely to be captured in randomised controlled trials (RCTs). The frequency of such rare events is more appropriately evaluated in prospective registries such as the National Prospective Tonsillectomy Audit conducted in England and Northern Ireland (BAO-HNS/RCSENG 2005) and the National Tonsil Surgery Registry conducted in Sweden (Söderman 2015), as discussed in Agreements and disagreements with other studies or reviews.

Quality of the evidence

As noted in Summary of findings for the main comparison, we have *low* or *very low-quality* evidence for all of our outcomes.

Unfortunately, despite the 29 studies and 2561 participants included in this review, the body of evidence is of such low quality that it precludes robust conclusions. Key methodological limitations affecting many of the studies included serious study design flaws affecting randomisation, the inability to blind the surgeon and other personnel in a surgical trial, and the difficulty of blinding personnel responsible for reporting outcomes, such as duration of surgery, operative blood loss and postoperative bleeding. Outcomes, particularly those that need to be measured as continuous outcomes (pain, intraoperative blood loss, duration of surgery, return to diet and activity) were not consistently measured across studies. Pain was measured using different instruments and at different time points. It was often unclear whether a validated instrument was used. In addition, most studies did not clearly specify who had filled in the forms, i.e. whether these were filled in by parents, children or clinicians, or if this was supervised. In situations where blinding was unclear or lacking, this is an important risk of bias. The impact of this bias could

potentially vary between different cultural and treatment settings and contribute to the high degree of unexplained heterogeneity observed.

Extreme statistical heterogeneity and methods of measurement/definition precluded pooling or meta-analysis for four outcomes: return to normal diet, return to normal activity, duration of surgery and intraoperative blood loss. Different parameters were used to measure intraoperative blood loss, making it impossible to pool the results at all for interpretation. Definitions of 'return to normal diet' or 'normal activity' were often not available. These inconsistencies are likely to contribute to the high degree of unexplained statistical heterogeneity in the results. It is also possible that the heterogeneity observed in return to normal diet and return to normal activity may reflect differences in pre- or postoperative instructions about pain medication and how and when to resume normal diet and activities, as well as different cultural expectations and norms across populations. These factors may be difficult to standardise in future RCTs, but clear information about the relevant protocols or definition of measurements should be provided to allow for assessment.

In contrast, the heterogeneity observed in duration of surgery likely reflects non-standardised beginning and end time points. Similarly, the heterogeneity observed in operative blood loss is in part due to non-standardised measurement methods. Some studies painstakingly measured blood loss using paediatric volumetric canisters; others used the surgeon's estimates. Some studies carefully excluded from this estimate blood loss from associated adenoidectomy or saline irrigation from the coblation device. Ultimately, the great heterogeneity among the these outcomes precluded us from pooling the studies to obtain a summary measure of effect. However, these factors could be easily standardised in future RCTs. The small size of most of these studies also precludes identification of a true difference, if one exists. For these reasons, although there may be true differences between coblation and comparator techniques, with the current studies we are unable to detect a difference and cannot determine whether a summary measure for any of these outcomes would favour coblation or the comparator.

Many studies in this review had a limited follow-up duration: 15 of 29 studies had less than 14 days of follow-up, but most of these had at least 10 days of follow-up. Although many surgeons consider the patient to be at risk of secondary haemorrhage during the 14 days after surgery, this is not proven. While consistent follow-up of at least 14 days would theoretically have improved the completeness (i.e. total number of events, or absolute risk) of secondary haemorrhage events captured, there is no known difference in the timing of secondary haemorrhage for coblation tonsillectomy compared to other techniques (i.e. whether people who have coblation surgery are more likely to have late secondary haemorrhage events). Therefore, it is not likely that this shorter duration of follow-up will bias the result, which is measured as a relative risk. Finally, in this meta-analysis we found bleeding rates comparable to those of well-conducted registry studies, also indicating that this shorter duration of follow-up did not appreciably impact our results.

Imprecision is still a serious issue with the pooled estimates despite the review having more than 2500 participants from 29 studies. Studies also often did not report enough information to allow for meta-analysis, and the possibility of selective reporting bias for non-statistically significant results cannot be excluded. This is a major problem for the studies found in this review, as most of them are small and might not be powered to detect statistical significance. Most studies provided enough information about primary and secondary bleeding but the estimates for these outcomes still had wide confidence intervals due to the low event rates.

Potential biases in the review process

The greatest challenge faced by the review team was inconsistent outcome reporting across studies. The inconsistency affected how outcomes were defined, collected and reported, with differences in definitions, timing of measurement and choice of metrics. Some outcomes, such as pain, suffered further inconsistency because they were reported at inconsistent time points. As a result, there was no obvious choice as to which outcome measures could be used for meta-analysis. Through discussion we reached consensus on these topics prior to undertaking this review. We made this determination based on the importance of each outcome to patients, clinicians and decision-makers. If data were not fully reported or available in the format we required, we contacted the study authors. Despite an extensive systematic effort to contact authors, in most cases we were unable to obtain the required information and we had to exclude many studies from meta-analysis. The value of this pragmatic approach is that it minimises selective outcome reporting by the review team and minimises the risk of a type II error through multiple analyses.

We found six studies reported in languages other than English (Guo 2012; Kim 2013a; Wang 2005; Wang 2009; Wang 2010; Zhong 2006). Although all of them were published as full-text manuscripts the methodology described in some of them is extremely limited (Wang 2005; Wang 2009; Wang 2010; Zhong 2006). We systematically attempted to contact the study authors by both email and post (organised through Cochrane ENT), but obtained no useful additional information. Although we were assisted by very able translators, it was often difficult to be certain about the type of data reported and as a result we were particularly concerned about including these studies in the meta-analyses. For example, many studies were unclear or contradictory about whether data were mean or median values. We were also concerned about whether standard deviation (SD) values were in fact SDs or standard errors (SEs). One of the studies affected, Wang 2009, had effect sizes that were larger than the other studies. We did query whether this was because the SD reported was actually a SE but after looking at the report carefully we concluded that this was unlikely. Firstly, if the values reported were SE then the SD estimated would be too large and for some of the data points implausible for the length of the scale used. Secondly, some data would no longer be statistically significant (as reported in the paper). We followed the recommendations within the *Cochrane Handbook for Systematic Reviews of Interventions* and included these studies in our analyses (Handbook 2011). Had we excluded these non-English studies, then we would have been at risk of selective reporting bias. We attempted sensitivity analysis by removing these and other studies at high risk of bias, but because nearly all of the studies were at high risk of bias this procedure was futile. For transparency to the reader, we have displayed the risks of bias alongside the forest plots.

Agreements and disagreements with other studies or reviews

Our finding that there is no clinically meaningful difference in pain is in agreement with a recent review (Xie 2008). This meta-analysis of four RCTs (Parsons 2006; Shah 2002; Stoker 2004; Temple 2001) compared coblation with monopolar cautery, ultrasonic scalpel and bipolar dissection. The authors concluded that "coblation tonsillectomy may be associated with less post-operative pain and a more rapid return to normal diet, though it is unclear if the magnitude of the benefit is clinically significant. The two techniques do not differ significantly in terms of post-operative blood loss or return to full activity. This benefit can be achieved at a net cost of $185 per procedure."

Our finding that there appears to be a greater risk of secondary bleeding with coblation is consistent with other studies. A large, population-based study, the National Prospective Tonsillectomy Audit conducted in England and Northern Ireland, found that the adjusted odds of any bleeding were 3.1 times higher (95% CI 2.0 to 4.7) for coblation compared to cold steel with ties/packs and the adjusted odds for bleeding requiring a return to the operating room were 2.8 times higher (95% CI 1.6 to 5.2) for coblation compared to cold steel with ties/packs (BAO-HNS/RCSENG 2005). A second large, population-based study, the National Tonsil Surgery Registry conducted in Sweden (Söderman 2015), found that all hot techniques conferred a greater risk of secondary haemorrhage compared to cold techniques. Compared to cold dissection and cold haemostasis, the risk of secondary haemorrhage was 2.8 times higher after cold dissection with hot haemostasis, 3.2 times higher after coblation, 4.3 times higher after diathermy scissors and 5.6 times higher after harmonic scalpel. A third study, a systematic review, found that the odds of secondary bleeding were 34 times higher (95% CrI [credible interval] 1.25 to 5676) for coblation compared to cold steel with packs/ties and the odds of secondary bleeding requiring a return to the operating room were four times higher (95% CrI 1.29 to 12.12) for coblation compared to cold steel with ties/packs (Mowatt 2006).

In view of the lack of a meaningful clinical difference in pain, the repeated observation of a higher risk of secondary bleeding requiring return to surgery, which has been documented in multiple reviews, and the increased cost associated with the device, at this time there seems to be no benefit to coblation.

AUTHORS' CONCLUSIONS

Implications for practice

Based upon a relatively large number of randomised controlled trials (RCTs) comparing coblation tonsillectomy with more conventional methods, there seems to be no benefit to coblation. However, this conclusion is uncertain due to very poor methodology and data reporting in most studies. Whilst this doubt does exist, previously published, high-quality data indicate that coblation tonsillectomy is associated with a clinically significant greater risk of postoperative bleeding requiring return to the operating room. As a result, we suggest that coblation tonsillectomy should be confined to well-designed and adequately executed RCTs in which postoperative bleeding rates are rigorously monitored and consistently reported in a manner that permits subsequent meta-analysis.

Implications for research

Evidence

The quality of evidence for all of the outcomes in this review was *low* or *very low*.

The sizes of the included studies were too small and they lacked statistical power to reach conclusions about the effectiveness or safety of coblation tonsillectomy. Meta-analysis is a crucial technique that allows data from multiple studies to be synthesised with improved statistical power. However, data in the included studies were not consistently collected or reported in a way that allowed meta-analysis of all published data.

The nature of surgical studies precludes blinding of the surgeon and that risk of bias cannot be mitigated. However, it is essential to reduce other potential sources of bias when possible. The current review demonstrates that outcome measures are the primary limitation in many tonsillectomy trials. Before further trials are planned, it is crucial to determine which outcomes are important and the timing and method by which each outcome should be measured. International efforts to achieve consensus, such as COMET (www.comet.org), may decrease the variability of outcome reporting across studies and enable subsequent meta-analysis. For example, as we demonstrate in this review, there are major limitations in how pain is measured. The specific measurement tool must be valid for i) the patient age group, ii) the condition (acute postoperative pain) and iii) the setting (language and culture).

Research is also needed to guide future trials about which are the most relevant time points to measure pain. For example, should studies average the pain score over a period of time, or pick certain time points that are most relevant to patient outcomes? The measurement of volume of blood loss during the operation and duration of surgery were also not interpretable across studies; future research or an expert consensus is needed to standardise these measurement methods.

In addition to limitations in the outcome measures, many included studies contained heterogeneous populations in terms of age groups, surgical indications, types of procedures (with or without adenoidectomy) and methods of haemostasis. The studies did not stratify patients according to these factors prior to randomisation and after randomisation these factors were not well reported.

Design

RCTs remain an appropriate design to assess some aspects of the safety and effectiveness of coblation tonsillectomy. These should be parallel-group RCTs and the unit of randomisation should be the patient, not the tonsil. If the study includes diverse patients, surgical indications, procedures or methods of haemostasis, stratification should be considered. The patients, outcome assessors and clinicians caring for patients after surgery should not be aware of the treatment group. The surgical team cannot be blinded to the treatment, but treatment in both groups should be performed by teams with similar experience and expertise in the techniques investigated. Consistent use of validated age-appropriate pain scales will reduce risk of bias and heterogeneity, and facilitate comparisons among studies.

Patients should be followed up for at least 14 days, and perhaps longer, as secondary haemorrhage does occur beyond 14 days

(Hultcrantz 2013). Primary and secondary haemorrhage are very rare events, therefore RCTs cannot estimate the true rate of these complications. A prospective audit or registry of all patients undergoing tonsillectomy would evaluate a greater number of patients and thus better estimate the true complication rate. Therefore, if the primary objective is to study the risk of bleeding after tonsillectomy, an RCT is an inappropriate study design and a prospective audit or registry study should be planned instead.

Population

The population to be studied should be adults and children undergoing tonsillectomy. However, studies should limit the population to either adults or children and should also limit the study according to how much tissue removal is planned (tonsillectomy only or tonsillectomy with adenoidectomy). Alternatively, studies may stratify patients prior to randomisation so that these factors may be assessed in predefined subgroups.

Intervention and comparison

The intervention is coblation tonsillectomy using the Coblator II (or later) system, performed by a surgeon with coblation experience.

Future RCTs of coblation tonsillectomy should design the comparator group to utilise only **one** of the common tonsillectomy techniques in a clearly described and consistent fashion. Comparison techniques might include the following:

- 'Cold steel' dissection tonsillectomy with ties/packs to secure haemostasis. Consideration may be given to allowing the use of limited, 'point' diathermy for haemostasis, particularly if this were also allowed in the intervention arm of the trial. This use of diathermy should be clearly documented to allow for subsequent meta-analysis of this as a distinct surgical technique.
- Monopolar diathermy tonsillectomy.
- Bipolar diathermy tonsillectomy.

For both the intervention and comparison group, use of additional methods, especially haemostasis methods, should be prespecified in the trial protocol. The trial protocol should be very specific about the techniques used and include the criteria for when other methods are allowed. The use of any additional techniques should be clearly reported in the trial report.

Outcomes

Essential outcome measures that should be measured include:

- Pain assessed using a pain scale validated in the relevant age group and condition (a visual analogue scale should not be used to assess pain in young children).
- Time to return to normal diet.
- Time to return to normal activity.

Cultural differences may have an impact on patients' experience and reporting of return to 'normal' diet and activity and this should be defined in the protocol for future studies. Some of the heterogeneity we observed may be minimised if future RCTs use standardised patient education and data collection methods for these outcome measures. Since patient compliance with self-reported outcomes is often poor, researchers must anticipate poor follow-up and must design their studies to minimise this. Researchers should consider using investigator-initiated telephone follow-up to collect these data.

Additional outcome measures that may be of interest, but which must be systematically measured and reported using a validated method and continuous measure, include:

- Duration of surgery.
- Perioperative blood loss.

It is important that research or consensus to establish validated ways of measuring these outcomes are conducted first, before new RCTs are conducted. Future trials will otherwise also be limited by the lack of use of validated measures.

All future RCTs should be reported using the CONSORT guidelines to prevent the difficulties we experienced in extracting the necessary trial data from trialists and trial publications (CONSORT 2010).

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Anthony 2006

Methods	Parallel, single-blinded, randomised controlled trial with 14 days follow-up

Participants	**Setting:** United Kingdom, single-district general hospital
	
	Sample size: 274
	
	• **Number randomised:** 274
	• **Number completed:** 163 (coblation 66, cold dissection 97)
	
	Inclusion criteria: adults and children undergoing tonsillectomy for recurrent tonsillitis
	Exclusion criteria: obstructive sleep apnoea, coagulopathy, any condition that might pertain to normal diet, tonsillitis within 2 weeks of surgery, failure to return completed questionnaire
	
	Baseline characteristics:
	
	• **Age:** 3 to 64 years
	  * Adults 16 to 64 years, children 2 to 15 years
	  * Coblation 3 to 64 years, cold dissection 3 to 44 years
	• **Gender**
	  * Coblation 68% female, cold dissection 62% female

Interventions	**Coblation group:** n = 136 **Cold dissection group:** n = 138 **Use of additional interventions:** Coblation tonsillectomy (136 patients) versus standard cold steel dissection tonsillectomy with clip and tie haemostasis (138 patients). "Standard post-op analgesia".
Outcomes	Postoperative pain (VAS 0 to 4), postoperative analgesia use, number of days to normal diet, secondary bleeding
Funding sources	No information available
Declarations of interest	No information available

Anthony 2006 *(Continued)*

Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients were individually randomised using computer-generated random numbers with adult and child groupings. The allocation sequence was generated by the hospital statistician.
Allocation concealment (selection bias)	High risk	Opaque, sealed envelopes were opened by the theatre scrub nurse approximately 1 hour prior to surgery. "... a small number of patients were selected by the surgeon for conventional surgery following randomisation that was felt to pose technical difficulties for coblation. The 6 patients who received dissection when randomised to coblation could introduce bias as this may have been a reason not to return the diary."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Quote: "The allocation schedule was kept at a separate hospital during the trial and the codes broken once the last day 14 assessment on the last patient was performed." Personnel: high Quote: "Only personnel present in the theatre operating room were aware of the operative technique performed." No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Quote: "One patient insisted on knowing the type of treatment he received." Personnel: high

Incomplete outcome data (attrition bias)
All outcomes
	High risk	**Participants lost to follow-up:** 111/274 (40.5%)
		• Coblation group: 70/136
		• Cold dissection group: 41/138
		
		Patients excluded from analysis: 7
		• 1 patient withdrew from the study post-randomisation - randomisation group not reported
		• 6 patients from coblation were excluded from analysis
		  * 1 patient due to personal choice
		  * 1 patient due to device malfunction
		  * 4 patients due to "technical reasons"

Selective reporting (reporting bias)	Unclear risk	No access to protocol; insufficient information to judge
Other potential sources of bias	Unclear risk	Unpublished study

Bäck 2001

Methods	Parallel, single-blinded randomised controlled trial with 21 days follow-up
Participants	**Setting:** Finland, single institution **Sample size:** • **Number randomised:** 40 • **Number completed:** 37 (7.5% excluded) **Inclusion criteria:** recurrent infection, chronic infection, airway obstruction, history of quinsy **Exclusion criteria:** bleeding disorders, significant chronic illness. The electrosurgery system was also contraindicated in patients with pacemakers or other electronic device implants. **Baseline characteristics:** • **Age:** overall 18 to 65 years; coblation median age 29.5, cold dissection median age 31.0 • **Gender:** coblation 8 males, 10 females; cold dissection 7 males, 12 females
Interventions	**Coblation group:** n = 18 • Bipolar ENTec coblator plasma surgery system • ENTec plasma scalpel wand **Cold dissection group:** n = 19 **Use of additional interventions:** Coblation group: point diathermy coagulation for haemostasis; cold dissection group: tonsil packs and bipolar diathermy for haemostasis
Outcomes	Duration of surgery, intraoperative blood loss, primary bleeding, secondary bleeding, pain medication in recovery room, postoperative pain using VAS 0 to 100, difficulty eating or drinking, analgesia usage, need for postoperative antibiotics, time in recovery room, intraoperative pain medication, adverse events
Funding sources	Helsinki University Central Hospital Funds
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Each patient was randomly assigned to either the coblation or cold dissection group by the surgeon picking a card from a pack of cards.
Allocation concealment (selection bias)	High risk	Each patient was randomly assigned to either the coblation or cold dissection group by the surgeon picking a card from a pack of cards. The timing of allocation relative enrolment is not stated and the risk is unclear.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel (operative): high

Bäck 2001 *(Continued)*

		Single surgeon. "None of the nursing staff taking care of the patient was aware of the group in which the patient was randomised, and the subjects were not informed until the telephone interview three weeks after the operation".
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel (operative): high
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0/40 (0%) **Proportion of patients receiving treatment as allocated:** 37/40 (93%) • Coblation group: 18/20 (90%); 2/20 patients did not have surgery • Cold dissection: 19/20 (95%); 1/20 patient elected to receive other surgical technique **Patients excluded after randomisation:** 3/40 (8%) • 1 patient developed severe postoperative pneumonia • 1 patient previously had a single tonsil removed • 1 patient cancelled surgery
Selective reporting (reporting bias)	High risk	Did not report several outcomes described in abstract/methods: intraoperative pain medication, postoperative complications
Other potential sources of bias	Unclear risk	Intraoperative bleeding volume was statistically significantly higher in the coblation group (median 80 mL) versus the cold dissection group (median 20 mL), P = 0.002. The authors attributed the difference to a learning curve with the new technique (coblation), though they did not find a correlation between decreasing blood loss and the number of surgeries performed with the new technique. Higher than conventionally reported secondary haemorrhage rates reported in both groups: coblation group 8/19, cold dissection 9/18

D'Eredità 2009

Methods	Parallel, single-blinded randomised controlled trial with 10 days follow-up

Participants	**Setting:** Italy, single tertiary care paediatric hospital
	
	Sample size: 157
	
	• **Number randomised:** 157
	• **Number completed:** 148
	
	Inclusion criteria: paediatric patients undergoing tonsillectomy alone - without adenoidectomy or other procedures; tonsillar hypertrophy or recurrent tonsillitis
	Exclusion criteria: undergoing other procedures
	
	Baseline characteristics:
	
	• **Age:** 3 to 11, mean age 5 years
	  * Coblation group: mean age 5 years
	  * Molecular resonance group: mean age 5 years
	• **Gender:** not reported

Interventions	**Coblation group:**

D'Eredità 2009 *(Continued)*

	n = 78 **Molecular resonance group:** n = 79 **Use of additional interventions:** All procedures were performed by the same attending surgeon. No local anaesthesia was applied in either group. After induction and prior to surgery, all patients were given a dose of betamethasone (0.1 mL/kg IV, max. 4 mg) and rectal acetaminophen (20 mg/kg). All patients were treated with an overnight observation.
Outcomes	Duration of surgery, intraoperative blood loss, postoperative pain (Wong Baker FACES 0 to 5), weight loss, histopathology of excised tonsils, return to normal diet, analgesia consumption, multiple awakenings during the night, voice changes, nausea, vomiting, change in behavior, primary bleeding, secondary bleeding, adverse events (including deaths, prolongation of hospital stay, readmission (for dehydration or poor PO intake))
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was obtained with a computer-generated table"
Allocation concealment (selection bias)	Low risk	Quote: "... the allocated procedures were placed in a numbered container to be opened by the scrub nurse upon preparation of the OR table the day of surgery. The allocation sequence was therefore concealed until surgery took place."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel: high; single surgeon
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel: high
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 9/157 (6%) • Coblation group: 4/78 (5%) • Molecular resonance group: 5/79 (6%) **Proportion of patients receiving treatment as allocated:** 157/157 (100%)
Selective reporting (reporting bias)	High risk	Did not report several outcomes described in abstract/methods: duration of surgery, return to normal diet
Other potential sources of bias	Low risk	None identified

D'Eredità 2010

Methods	Parallel, single-blinded, randomised controlled trial with 10 days follow-up

Participants	**Setting:** Italy, single tertiary care paediatric hospital
	
	Sample size:
	
	• **Number randomised:** 96
	• **Number completed:** 96
	• 103 patients eligible, 96 enrolled and randomised, none lost to follow-up
	
	Inclusion criteria: recurrent tonsillitis and/or airway obstruction caused by adenotonsillar hypertrophy
	Exclusion criteria: bleeding disorders, craniofacial malformations, previous adenotonsillectomy, suspected lymphoma and mental retardation
	
	Baseline characteristics:
	
	• **Age:** 2 to 18
	  * Coblation group: mean age 6.1
	  * Monopolar electrocautery group: mean age 5.6
	  * Molecular resonance group: mean age 5.9
	• **Gender:**
	  * Coblation group: 16 male, 16 female
	  * Monopolar electrocautery group: 15 male, 17 female
	  * Molecular resonance group: 15 male, 17 female

Interventions	**Coblation group:** n = 32 **Monopolar electrocautery group:** n = 32 **Molecular resonance group:** n= 32 **Use of additional interventions:** Coblation assisted tonsillectomy or adenotonsillectomy (32), monopolar cautery tonsillectomy or adenotonsillectomy (32), molecular resonance tonsillectomy or adenotonsillectomy (32)
Outcomes	Postoperative pain (Wong Baker FACES 0 to 5), primary bleeding, secondary bleeding, intraoperative blood loss, analgesia use, cost (calculated based on operating room time, total anaesthesia time, other costs)
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement

D'Eredità 2010 *(Continued)*

Random sequence generation (selection bias)	Low risk	Quote: "computer-generated table"
Allocation concealment (selection bias)	Low risk	Quote: "Randomization was obtained with a computer-generated table, and the allocated procedures were placed in a numbered container to be opened by the scrub nurse upon preparation of the OR table the day of surgery."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients, parents: low Personnel: high; single surgeon
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients, parents: low Personnel: high
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0 **Proportion of patients receiving treatment as allocated:** 96/96 (100%)
Selective reporting (reporting bias)	High risk	Did not report several outcomes described in abstract/methods: diet, voice and activity
Other potential sources of bias	Low risk	None identified

Elbadawey 2015

Methods	Parallel, single-blinded, randomised controlled trial with 14 days follow-up

Participants	**Setting:** Saudi Arabia
	Sample size: 120
	• **Number randomised:** 120
	• **Number completed:** 120 (coblation 40, laser 40, cold dissection 40)
	Inclusion criteria: children undergoing tonsillectomy for recurrent tonsillitis
	Exclusion criteria: bleeding disorders, previous quinsy, debilitating diseases and combined surgeries (e.g. adenotonsillectomy) and those who underwent tonsillectomy for obstructive sleep apnoea were excluded
	Baseline characteristics:
	• **Age:** 5 to 15 years
	  * Coblation: mean 10 years, SD 2.8 years
	  * Laser diode: mean 10 years, SD 2.5 years
	  * Cold dissection: mean 10 years, SD 3.2 years
	• **Gender**
	  * Coblation: female 19 patients (47.5%)
	  * Laser diode: female 21 patients (52.5%)

Interventions	**Coblation group:** n = 40 **Laser diode group:** n = 40 **Cold dissection group:** n = 40

Elbadawey 2015 *(Continued)*

	Use of additional interventions: laser diode and cold dissection groups described as using bipolar diathermy for haemostasis; for all groups "all patients received standard postoperative care and were discharged after one day with medication sufficient for seven days comprising analgesic drugs and mouthwash. Patients were followed up at the end of the first and second postoperative weeks."
Outcomes	Postoperative pain (postoperative day 1, 7, 14) Wong Baker FACES, time until normal diet, primary bleeding, secondary bleeding, duration of surgery, dehydration, infection
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Patient randomisation was achieved by preparing 120 brown envelopes, each containing a slip of preprinted paper indicating the techniques to be used in the procedure: 40 envelopes each with diode laser tonsillectomy, coblation tonsillectomy and cold dissection tonsillectomy. On the day of surgery, the surgeon was given an envelope selected at random by one of the nurses to reveal the technique to be used. All patients, parents and recovery nurses were blinded to the surgical technique."
Allocation concealment (selection bias)	Low risk	"Patient randomisation was achieved by preparing 120 brown envelopes, each containing a slip of preprinted paper indicating the techniques to be used in the procedure: 40 envelopes each with diode laser tonsillectomy, coblation tonsillectomy and cold dissection tonsillectomy. On the day of surgery, the surgeon was given an envelope selected at random by one of the nurses to reveal the technique to be used. All patients, parents and recovery nurses were blinded to the surgical technique."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: blinded Personnel: not blinded; single surgeon "Parents were blinded to the surgical techniques used in the study" Discussion: "The main limitation of our study is that the surgeon was not blinded to the technique used. However, this would be impossible and reporter bias was reduced by blinding patients and their families to the technique used. Unbiased postoperative assessment was ensured by using a nurse-led follow-up service which did not involve the operating surgeon."
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: blinded Personnel: not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0/120 (0%) Coblation group: 0/40 Diode laser group: 0/40

Elbadawey 2015 *(Continued)*

		Cold dissection group: 0/40 Patients excluded from analysis: 0/120 (0%)
Selective reporting (reporting bias)	Low risk	Dehydration and infection were listed as outcomes but not reported
Other potential sources of bias	Low risk	None identified

Guo 2012

Methods	Randomised controlled trial with 7 days follow-up
Participants	**Setting:** China, hospital-based **Sample size:** • **Number randomised:** 64 • **Number completed:** 64 • Number eligible not stated **Inclusion criteria:** chronic tonsillitis with acute onset 4 or more times per year, focal chronic tonsillitis **Exclusion criteria:** not stated **Baseline characteristics:** • **Age:** adults 15 to 62 years • **Gender:** not specified
Interventions	**Coblation group:** n = 25 **Cold dissection group:** n = 39 **Use of additional interventions:** no other intervention described
Outcomes	Postoperative pain, intraoperative blood loss, duration of surgery, postoperative bleeding (study does not distinguish between primary and secondary), return to normal activity (measured in hours)
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described. Unbalanced (not 1:1) number of patients in each group noted.
Allocation concealment (selection bias)	Unclear risk	Not described

Guo 2012 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Not described
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported **Proportion of patients receiving treatment as allocated:** not reported
Selective reporting (reporting bias)	Unclear risk	No access to protocol; insufficient information to judge
Other potential sources of bias	Low risk	Translated study

Gustavii 2010

Methods	Parallel, single-blinded randomised controlled trial with 14 days follow-up
Participants	**Setting:** Sweden, county hospital **Sample size:** 80 • **Number randomised:** 80 (42 children, 38 adults) • **Number completed:** 57 (24 children, 23 adults) **Inclusion criteria:** recurrent or chronic tonsillitis, including tonsillary hyperplasia with obstructive symptoms **Exclusion criteria:** coagulation disturbances, peritonsillar abscess, relevant drug allergies, obstructive sleep apnoea and an age below 4 years or above 65 years **Baseline characteristics** • **Age:** 6 to 57 years • **Gender:** 37 males, 43 females
Interventions	**Coblation group:** n = 41 **Cold dissection group:** n = 38 **Use of additional interventions:** Coblation tonsillectomy versus traditional cutting with bipolar cautery for haemostasis Triazolam or midazolam as needed preoperatively All patients received intraoperative injection with mepivacaine
Outcomes	Postoperative pain scores, primary bleeding, secondary bleeding, odynophagia, pain with swallowing, amount of analgesia and activity limitations

Gustavii 2010 *(Continued)*

Funding sources	The Fyrbodal Research and Development Council
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomisation in balanced groups of 4. A randomisation list was generated on line in blocks of 4 to achieve about the same size in both groups: ABBA, ABAB, BBAA, etc, with the 6 permutations occurring in random order (personal communication from Dr. Bove).
Allocation concealment (selection bias)	High risk	Allocation was maintained by study nurse and concealed from surgical staff until the time of surgery. If block sizes were small, it is possible the staff may have divined the randomisation scheme during the enrolment process.
Blinding of participants and personnel (performance bias) All outcomes	High risk	All patients and the parents of included children were blinded to the group assignment for the duration of the study. Members of the postoperative staff were blinded. Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	All patients and the parents of included children were blinded to the group assignment for the duration of the study.
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up:** 0/80 • Coblation group: 0/41 • Cold dissection group: 0/38 **Proportion of participants receiving treatment as allocated:** 79/80 (99%) • 1 adult withdrew after randomisation but the authors do not report which group he had been randomised to (unclear which group) **Proportion of participants enrolled, randomised and allocated who were included in analysis:** 57/80 (71%) **Participants with incomplete postoperative questionnaires:** 22/80 (28%) • 8 children and 14 adults • Coblation group; 13/41 (31.7%) • Cold dissection group: 9/38 (23.6%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Hasan 2008

Methods	Parallel, single-blinded randomised controlled trial with 14 days follow-up
Participants	**Setting:** Finland, hospital **Sample size** • **Number randomised:** 40 • **Number completed:** 40 **Inclusion criteria:** chronic or recurrent tonsillitis **Exclusion criteria:** patients with history of quinsy, bleeding disorder or other major health problems were excluded **Baseline characteristics:** • **Age: median age 32 years** (18 to 55) • **Gender:** 16 male 24 female
Interventions	**Coblation group:** n = 20 **Bipolar dissection group:** n = 20 **Use of additional interventions:** Bipolar cautery for haemostasis in either group Tylenol plus codeine pre-med Cetirizine Ketoprofen during the procedure
Outcomes	Postoperative pain (VAS 0 to 10), analgesia use, return to normal diet, return to normal activity (work), primary bleeding, secondary bleeding, duration of surgery, surgeon's report of ease of operation, intra-operative blood loss
Funding sources	No information available
Declarations of interest	No information available
Notes	All operations were performed by the same senior surgeon

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were allocated into 2 groups according to a randomly generated number sequence on the day of operation by the operating surgeon.
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients, parents: low Personnel: high; single surgeon

Hasan 2008 *(Continued)*

Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients, parents: low Personnel: high
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up:** 0/40 **Proportion of participants receiving treatment as allocated:** 40/40 (100%) **Patients excluded from portion of analysis:** 5/40 • This study excluded 3 patients who returned to the operating room for management of secondary bleeding from pain analyses starting with the day on which they returned to the operating room. • 1 patient did not complete pain ratings starting on postoperative day 7 (by Hasan et al's convention, this would be postoperative day 8). • 1 patient did not complete pain rating on postoperative day 4 (by Hasan et al's convention).
Selective reporting (reporting bias)	High risk	All measured outcomes reported in some fashion. However, numerical data not provided for some outcomes: return to normal diet, return to normal activity.
Other potential sources of bias	Low risk	None identified

Hong 2013

Methods	Parallel, single-blinded randomised controlled trial with 28 days of follow-up
Participants	**Setting:** South Korea, University Hospital **Sample size:** 80 • **Number randomised:** 80 • **Number completed:** unclear **Inclusion criteria:** patients who underwent tonsillectomy with a history of recurrent tonsillitis **Exclusion criteria:** acute inflammation, sleep apnoea, congenital anomalies, a history of peritonsillar abscess, coagulation disorders, a history of taking anticoagulants, neoplasms and previous tonsillectomy with adenoidectomy **Baseline characteristics:** • **Age:** 16 to 53 years • **Gender:** 31 male, 49 female • No significant age and gender differences between groups
Interventions	**Coblation group:** n = 40 • ENT Coblator II • 8 Watts cutting • 5 Watts cauterise **Monopolar electrocautery group:** n = 40

Hong 2013 *(Continued)*

- Electrocautery, Valleylab Force 2 ESU
- 20 Watts cutting
- 25 Watts cauterise

Use of additional interventions: none

Outcomes	Postoperative pain (VAS 0 to 6), return to normal diet, primary bleeding, secondary bleeding, intraoperative blood loss (cotton ball count), otalgia, wound healing, foreign body sensation
Funding sources	Korea Health technology R&D Project, Ministry of Health & Welfare, Republic of Korea (A090084)
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients: low "patients were unaware of the surgical technique used" Personnel: high "All operations were performed by the same surgeon who was skilled in both surgical techniques and was unaware of the operative technique until entering the operation room." Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients: low "patients were unaware of the surgical technique used" Personnel: high "All operations were performed by the same surgeon who was skilled in both surgical techniques and was unaware of the operative technique until entering the operation room."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Monopolar electrocautery group: not reported **Proportion of participants receiving treatment as allocated:** not reported • Coblation group: not reported • Monopolar electrocautery group: not reported
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Jayasinghe 2005

Methods	Parallel, single-blinded, randomised controlled trial with 11 days of follow-up
Participants	**Setting:** tertiary referral centre, UK **Sample size:** • **Number randomised:** 60 • **Number completed:** 40 **Inclusion criteria:** not available **Exclusion criteria:** not available **Baseline characteristics:** • **Age:** 18 to 65 years • **Gender** not reported
Interventions	**Coblation group:** n = 30 **Cold dissection group:** n = 30 **Use of additional interventions:** Coblation tonsillectomy (30 patients) versus cold steel dissection tonsillectomy with diathermy haemostasis (30 patients)
Outcomes	Duration of surgery, intraoperative blood loss, postoperative pain (VAS 1 to 10), adverse events (post-operative complications), primary bleeding, secondary bleeding
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	The names of patients consenting for the study were written on equal-sized pieces of paper and placed in a container. The container was shaken and the first 30 assigned to coblation. The remaining to cold steel with diathermy.
Allocation concealment (selection bias)	Low risk	Patient assignment was concealed in an envelope that was opened by the surgeon just before the procedure.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants were blinded. Personnel were not blinded. No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients: low (blinded) Personnel: high (unblinded)

Jayasinghe 2005 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up:** 20/60 (33%) • Coblation group: 9/30 • Cold dissection group: 11/30 **Proportion of participants receiving treatment as allocated:** 60/60 (100%) • Coblation group: 30/30 • Cold dissection group: 30/30
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Unclear risk	Unpublished study

Kim 2013a

Methods	Parallel randomised controlled trial with unclear follow-up period
Participants	**Setting:** South Korea **Sample size:** 65 • **Number randomised:** 61 • **Number completed:** 61 **Inclusion criteria:** "Patients that underwent bilateral tonsillectomy" **Exclusion criteria:** "Patients that had minor hypertrophy, chronic tonsillitis without hypertrophy, concomitant nasal surgery for snoring or abscess around tonsil." **Baseline characteristics** • **Age:** 10 to 58 years • **Gender:** 25 males, 36 females
Interventions	**Coblation group:** n = 19 **Cold dissection (not included in meta-analysis):** n = 8 **Monopolar electrocautery**: n=18 **Laser tonsillectomy:** n=16 **Use of additional interventions:** None reported
Outcomes	Duration of surgery, throat pain (VAS 0 to 10), ear pain, primary bleeding, secondary bleeding
Funding sources	No information available

Kim 2013a *(Continued)*

Declarations of interest	No information available
Notes	This study included multiple dissection techniques - consistent with this systematic review's methodology, the patients in the laser tonsillectomy group were not eligible for inclusion in the meta-analysis. The small number of patients in the cold dissection group were excluded to facilitate inclusion of a greater number of patients in the meta-analysis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No description of randomisation method
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: not described Personnel: not blinded
Blinding of outcome assessment (detection bias) Intraoperative blood loss	High risk	Participants: not reported if patients were blinded. Our review of this study does not include any patient-assessed outcomes, only personnel assessed outcomes. Thus the risk of bias is high based on lack of blinding of personnel.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Patients in "sample size": 65 **Proportion of participants receiving treatment as allocated:** 61/61 (100%) • Coblation group: 19/19 • Monopolar electrocautery group: 18/18 • Laser tonsillectomy group: 16/16 • Cold dissection group: 8/8
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	Translated study

Matin 2013

Methods	Parallel randomised controlled trial with 8 days of follow-up
Participants	**Setting:** Bangladesh; one general and one specialised hospital between January 2008 and December 2011 **Sample size:** 200 • **Number randomised:** 200 • **Number completed:** 200 (unclear) **Inclusion criteria:** none stated **Exclusion criteria:** none stated

Matin 2013 *(Continued)*

	Baseline characteristics: • **Age:** coblation mean age 5.6 years (range 3 to 12 years), blunt dissection 7.2 years (range 4 to 14 years) • **Gender:** coblation 60 males, 40 females; cold (blunt) dissection 65 males, 35 females
Interventions	**Coblation group:** n = 100 **Cold dissection group:** n = 100 **Use of additional interventions:** Cold (blunt) dissection group used ligatures and bipolar for haemostasis. All patients were kept 1 day in the hospital. Postoperative antibiotics (cephradine) and analgesia (paracetamol and diclofenac as needed); regimens were standardised for both groups.
Outcomes	Duration of surgery, intraoperative bleeding, primary bleeding, secondary bleeding, postoperative pain (VAS 1 to 10), return to normal diet, adverse events
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"patient were randomised to either the coblation group or the conventional dissection group by equal number..." Method not described
Allocation concealment (selection bias)	Unclear risk	Method not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Method not described. No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Method not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Cold dissection group: not reported **Proportion of participants receiving treatment as allocated:** 200/200 (100%) • Coblation group: 100/100 (100%) • Cold dissection group: 100/100 (100%)

Matin 2013 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Mitic 2007

Methods	Parallel, single-blinded randomised controlled trial with 10 days of follow-up
Participants	**Setting:** Norway, hospital **Sample size:** 40 • **Number randomised:** 40 • **Number completed:** 40 **Inclusion criteria:** standard indications for tonsillectomy: 3 or more episodes of tonsillitis in a year for the last 2 years or obstructive symptoms related to tonsil hypertrophy. Selected paediatric patients were between 4 and 12 years and weighed 16 kg to 60 kg. August to December 2005. **Exclusion criteria:** patients with a history of bleeding disorder, asthma or other past medical history. History of tonsillitis within 3 weeks of surgery. Contraindications for NSAIDs. **Baseline characteristics:** the groups were statistically comparable by age, weight and operation type (tonsillectomy or adenoidectomy with tonsillectomy). • **Age:** overall range 4 to 12 years • **Gender:** not reported
Interventions	**Coblation group:** n = 20 **Cold dissection group:** n = 20 **Use of additional interventions:** Those undergoing dissection tonsillectomy also had bipolar cautery for haemostasis. Standard anaesthetic and pain regimen. Some patients (not specified) had concurrent adenoidectomy.
Outcomes	Postoperative pain (VAS 1 to 5), postoperative analgesia usage, activity score, nutrition score, return to normal day, intraoperative blood loss, duration of surgery, adverse events, primary bleeding, secondary bleeding
Funding sources	No information available
Declarations of interest	Stated "None to declare"
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement

Mitic 2007 *(Continued)*

Random sequence generation (selection bias)	Low risk	"A statistician made a list with randomized sequence of the two alternative treatments, and from this list a secretary made 40 numbered, sealed envelopes. For each operation the assisting nurse in the surgery room opened one envelope in sequential order and read the treatment allocated to the surgeon."
Allocation concealment (selection bias)	Low risk	"A statistician made a list with randomized sequence of the two alternative treatments, and from this list a secretary made 40 numbered, sealed envelopes. For each operation the assisting nurse in the surgery room opened one envelope in sequential order and read the treatment allocated to the surgeon."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients, parents: low Personnel: high "Patients, parents and nurses from the recovery ward were blinded for the operation method." Operating surgeon and operating room nurse ("assisting nurse") not blinded. Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients, parents: low Personnel: high "Patients, parents and nurses from the recovery ward were blinded for the operation method." Operating surgeon and operating room nurse ("assisting nurse") not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0/40 **Proportion of participants receiving treatment as allocated:** 40/40 (100%)
Selective reporting (reporting bias)	High risk	Did not report outcome described in abstract/methods: return to normal diet
Other potential sources of bias	Low risk	None identified

Omrani 2012

Methods	Parallel, single-blinded randomised controlled trial. Length of follow-up not specified.
Participants	**Setting:** Iran **Sample size:** 103 • **Number randomised:** 97 • **Number completed:** 94 **Inclusion criteria:** indications for tonsillectomy were chronic recurrent tonsillitis (without any history of tonsillitis within 4 weeks prior to surgery) and snoring with sleep apnoea **Exclusion criteria:** patients with a history of a peritonsillar abscess, ongoing analgesic use for medical conditions and bleeding disorders were excluded **Baseline characteristics:** • **Age:** coblation mean age 11.2 years; cold (traditional dissection) mean age 11.8 years; no significant difference between the mean age of 2 groups (P > 0.05)

Omrani 2012 *(Continued)*

- **Gender:** not discussed

Interventions	**Intervention group:** n = 49 **Cold dissection group:** n = 48 **Use of additional interventions:** standard anaesthetic. Unknown which patients received concurrent adenoidectomy.
Outcomes	Duration of surgery, intraoperative blood loss, postoperative pain (VAS 0 to 10), return to normal activity (also described as work and normal general condition), return to normal diet, primary bleeding, secondary bleeding
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization, using random number table, prior to surgery."
Allocation concealment (selection bias)	Unclear risk	"informed consent was obtained from each subject allowing randomisation, using random number table prior to surgery". "After beginning of anesthesia, the patient was allocated in each group by surgeon based on a randomly generated number sequence." It is unclear whether the details of the randomisation scheme were available to personnel performing the study enrolment. No further details could be obtained through our attempts to contact the author.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients: low Personnel, operative: high Personnel, follow-up: low "Follow up of all patients was performed by a second colleague to make the surgeon blind. On the other hand, none of patients were aware of type of procedure." No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients: low Personnel, operative: high Personnel, follow-up: low

Omrani 2012 *(Continued)*

		"Follow up of all patients was performed by a second colleague to make the surgeon blind. On the other hand, none of patients were aware of type of procedure."
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 3/97 (3%) • Coblation group: 2/49 (4%) • Cold dissection group:1/48 (2%) **Proportion of participants receiving treatment as allocated:** 97/97 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Paramasivan 2012

Methods	Parallel randomised controlled trial with 3 days of follow-up
Participants	**Setting:** India, Research Hospital **Sample size:** • **Number randomised:** 100 • **Number completed:** 100 **Inclusion criteria:** children in age group between 5 and 12 years with tonsillar and adenoid hypertrophy causing obstructive sleep apnoea. All the patients in the study group were evaluated with polysomnography before surgery to confirm the diagnosis. **Exclusion criteria:** children with septic tonsils **Baseline characteristics:** • **Age:** children between 5 and 12 years • **Gender:** not described
Interventions	**Coblation group:** n = 50 **Cold dissection group:** n = 50 **Use of additional interventions:** All patients underwent concurrent adenoidectomy. Haemostasis was achieved as described - coblation: bleeding secured with coblation; blunt dissection: (adenoid) bleeding arrested using postnasal pack, tonsillectomy was performed by blunt dissection and bleeding arrested with ligatures.
Outcomes	Postoperative pain, intraoperative blood loss (by weight converted to volume using "1 g = 1 ml"), duration of surgery, primary bleeding, secondary bleeding
Funding sources	No information available
Declarations of interest	No information available

Paramasivan 2012 *(Continued)*

Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not described
Allocation concealment (selection bias)	Unclear risk	Method not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients, parents: not described Personnel, operative: high. Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Patients, parents: not described Personnel, operative: high Personnel, follow-up: low "A blinded team member reviewed the patient on the same day of surgery after 6 h and on the 4th postoperative day"
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0/100 **Proportion of participants receiving treatment as allocated:** 100/100 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Parker 2009

Methods	Parallel, double-blinded randomised controlled trial with 10 days follow-up
Participants	**Setting:** single centre, secondary care children's hospital, United Kingdom **Sample size:** • **Number randomised:** 79 • **Number completed:** 70 **Inclusion criteria:** children undergoing tonsillectomy or adenotonsillectomy, between the ages of 4 and 16 at the Derby Children's Hospital **Exclusion criteria:** any child receiving regular analgesic medication for other conditions and any child returning to theatre for bleeding during the study period **Baseline characteristics:**

Parker 2009 *(Continued)*

- **Age:** 4 to 15 years, mean age 8.2 years
  - Coblation mean age 7.5 years, cold dissection mean age 7.5 years; tonsillectomy only mean age 9.5 years, adenotonsillectomy mean age 6.5 years. "The two groups were thus balanced for age."
- **Gender:** 44 females, 35 males

Interventions	**Coblation group:** n = 40 **Cold dissection group:** n = 39 **Use of additional interventions** "All the children who participated received the same preoperative analgesia, paracetamol, 30mg/kg. The same surgeon undertook all the surgical procedures, alongside three consultant anaesthetists, working to the same anaesthetic protocol. Identical postoperative analgesia was available to all the children involved."
Outcomes	Postoperative pain (Derbyshire ordinal scale), return to normal diet, amount of analgesia required, postoperative bleeding (study does not distinguish between primary and secondary)
Funding sources	No information available
Declarations of interest	Stated "none to declare"
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A computer generated random sequence, in sealed opaque envelopes, was opened once the patient was asleep in the operating room." "The randomisation sequence was generated and allocated by a second research nurse...."
Allocation concealment (selection bias)	Low risk	"A computer generated random sequence, in sealed opaque envelopes, was opened once the patient was asleep in the operating room." "The randomisation sequence was generated and allocated by a second research nurse...."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients, parents: low Personnel, operative: high "Neither the children, the parents or the nursing staff undertaking the pain assessments and prescribing the analgesia, were informed which technique had been used." Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients, parents: low Personnel, operative: high Personnel, follow-up: low "Neither the children, the parents or the nursing staff undertaking the pain assessments and prescribing the analgesia, were informed which technique had been used."
Incomplete outcome data (attrition bias)	High risk	**Participants lost to follow-up:** 9/79 (11%)

Parker 2009 *(Continued)*

All outcomes		• Coblation group: 5/40 (12.5%) • Cold dissection group: 4/39 (10%) **Proportion of participants receiving treatment as allocated:** 74/79 (94%) • Coblation group: 37/40 (93%) • Cold dissection group: 37/39 (95%) **Participants excluded from analyses due to postoperative bleeding:** 4/79 (5%) • Coblation group: 2/40 (5%) • Cold dissection group: 2/39 (5%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Parsons 2006

Methods	Parallel randomised controlled trial with 10 days follow-up

Participants	**Setting:** academic hospital, United States
	
	Sample size:
	
	• **Number randomised:** 134
	• **Number completed:** 61
	
	Inclusion criteria: all patients undergoing tonsillectomy or adenotonsillectomy between December 2002 and December 2004
	
	Exclusion criteria: none stated
	
	Baseline characteristics:
	
	• **Age:**
	  * Coblation (2.0 to 32.0, mean 9.5, SD 7.3) electrocautery (1.9 to 42.0, mean 10.1, SD 9.0) ultrasonic (1.9 to 33.0, mean 10.9, SD 8.8)
	• **Gender:**
	  * Coblation (28 female, 19 male), electrocautery (20 female, 23 male), ultrasonic (21 female 23 male)
	• Reportedly no age or gender differences between groups

Interventions	**Coblation group:** n = 47 **Monopolar electrocautery group:** n = 43 **Ultrasonic harmonic scalpel group**: n = 44 **Use of additional interventions**

Parsons 2006 *(Continued)*

	All patients were given similar medication for postoperative pain (acetaminophen with codeine) and antibiotics
Outcomes	Duration of surgery, intraoperative blood loss, postoperative pain (Wong Baker FACES 0 to 10), adverse events (postoperative complications), return to normal diet and activity, primary bleeding, secondary bleeding, need for postoperative analgesia
Funding sources	No information available
Declarations of interest	No information available
Notes	Email correspondence received; they were not able to provide requested data

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients were "randomly assigned" but the method of randomisation was not described
Allocation concealment (selection bias)	Unclear risk	No information available
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients: low Personnel: high "Patients were blinded." No further descriptions were provided. Operations were performed by otolaryngology resident trainees.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients: low Personnel: high "Patients were blinded". No further descriptions were provided.
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up** 73/147 (54.5%) • Coblation group 22/47 (47%) • Monopolar electrocautery group: 24/43 (56%) • Ultrasonic harmonic scalpel group: 27/44 (61%) Authors report no difference in baseline characteristics between those who completed the study and those lost to follow-up **Proportion of participants receiving treatment as allocated:** 133/134 (99%) • Coblation group 46/47 (98%) • Monopolar electrocautery group: 43/43 (100%) • Ultrasonic harmonic scalpel group: 44/44 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Philpott 2005

Methods	Parallel, single-blinded randomised controlled trial with 14 days follow-up
Participants	**Setting:** academic hospital, United Kingdom **Sample size:** 93 • **Number randomised:** 92 • **Number completed:** 71 **Inclusion criteria:** "[Adult] patients undergoing a tonsillectomy for a history of recurrent tonsillitis were included in the trial." **Exclusion criteria:** not explicitly stated **Baseline characteristics:** • **Age:** overall range 18 to 45 years • **Gender:** male 23, female 69
Interventions	**Coblation group:** n = 43 **Cold dissection group:** n = 49 **Use of additional interventions:** standardised anaesthetic protocol including intraoperative intravenous morphine (0.15 to 0.2 mg/kg). Same postoperative pain regimen of Co-codamol and Diclofenac. All patients stayed in hospital the night after surgery. All patients were prompted to remember to fill out postoperative questionnaires by telephone on postoperative days 3, 7 and 14.
Outcomes	Postoperative pain (preoperative, then postoperatively at 6 to 8 hours, 24 hours, 3 days, 7 days, 2 weeks), otalgia (preoperative, then postoperatively at 6 to 8 hours, 24 hours, 3 days, 7 days, 2 weeks), difficulty in swallowing (preoperative, then postoperatively at 6 to 8 hours, 24 hours, 3 days, 7 days, 2 weeks), use of analgesia, primary bleeding, secondary bleeding, return to normal diet, return to normal activity (work)
Funding sources	No information available
Declarations of interest	No information available
Notes	Personal communication received regarding blinding

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"We printed equal amounts of “coblation” and “dissection” tickets to enclose in the plain envelopes" (did not mention actual method of randomisation)
Allocation concealment (selection bias)	Low risk	"Randomization occurred in theatre once the patients were anaesthetized by means of a closed envelope system to allocate them to the coblation group or the cold dissection control group." (Did not mention opaque envelope; we assumed it was opaque).
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: unclear risk Personnel: high Participant blinding not described. "The assessor (first author) was blinded to the randomization procedure and the operating surgeons (D.C. Wild, D. Mehta,

Philpott 2005 *(Continued)*

		A.R. Banerjee, personal communication) were not involved in distributing the postoperative questionnaires, the telephone reminder or the analysis of the data." "One of three surgeons performed all of the procedures [D.C. Wild (SpR) 56, D. Mehta (SpR) 31, A.R.Banerjee (Consultant 5] using a standardized dissection technique. All three surgeons had performed at least 15 coblation tonsillectomies prior to performing the trial to eliminate a learning curve."
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Participant: unclear risk Personnel: high Participant blinding not described. "The assessor (first author) was blinded to the randomization procedure."
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up:** 0/92 • Coblation group: 0/43 • Cold dissection group: 0/49 **Proportion of participants receiving treatment as allocated:** 92/92 (100%) • Coblation group: 43/43 (100%) • Cold dissection group: 49/49 (100%) **Participants with incomplete postoperative questionnaires.:** 22/92 (24%) • Coblation group: 8/43 • Cold dissection group: 14/49
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Unclear risk	Higher than conventionally reported secondary haemorrhage rates reported in both groups: coblation group 11/43, cold dissection group 8/49

Roje 2009

Methods	Parallel, single-blinded randomised controlled trial with 14 days follow-up
Participants	**Setting:** academic hospital, Croatia **Sample size:** 102 • **Number randomised:** 89 • **Number completed:** 72 **Inclusion criteria:** inclusion criteria were age 3 to 16 years and indications for tonsillectomy according to the guidelines issued by the Ministry of Health and Social Welfare of the Republic of Croatia (upper airway obstruction, recurrent tonsillitis – 7 inflammations in one year, or 5 inflammations per year in 2 subsequent years, or 3 inflammations per year in 3 subsequent years, recurrent peritonsillar abscess, obstructive sleep apnoea and suspected malignant tonsillar disease). **Exclusion criteria:** exclusion criteria were absolute and relative contraindications for operative procedure (e.g. acute infection of upper airways, coagulation disorders (haemophilia), leukaemia, uncontrolled diabetes mellitus, active tuberculosis, agranulocytosis, etc.) **Baseline characteristics:** • **Age:** mean age for both groups 6 years; coblation group range 3 to 14 years; conventional group 3 to 15 years

Roje 2009 *(Continued)*

- **Gender:** male 41, female 31; "no statistically significant difference between the groups by... gender (p=0.811)" (only reported for those completing study)

Interventions	**Coblation group:** n = 45 **Cold dissection group:** n = 44 **Use of additional interventions:** Same surgeon, anaesthetist, postoperative regimen. Cold tonsillectomy (blunt dissection) utilised bipolar cautery for haemostasis
Outcomes	Histopathologic depth of thermal damage, intraoperative blood loss, postoperative pain severity assessed by analgesia usage, return to normal activity, primary bleeding, secondary bleeding
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was done by use of computer generated random number which used for selection children and separate them into groups from large ENT database containing children assigned for tonsillectomy by 2nd author."
Allocation concealment (selection bias)	Unclear risk	No concealment method described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel: high "Children's parents did not know what specific procedure (of two possible) was perform on their child." Surgeon not blinded. Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel: high
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up:** 15/89 (16.9%) • Coblation group: 7/45 (16%) • Cold dissection group: 8/44 (18%) **Proportion of participants receiving treatment as allocated:** 87/89 (98%) • Coblation group: 43/45 (96%) • Cold dissection group: 44/44 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.

Roje 2009 *(Continued)*

Other potential sources of bias	Unclear risk	Language in the manuscript describes those writing about the use of coblation as "technique pioneers," which could indicate a bias favouring a new technique

Roje 2011

Methods	Parallel, single-blinded randomised controlled trial with 14 days of follow-up
Participants	**Setting:** academic hospital, Croatia **Sample size:** • **Number randomised:** 109 • **Number completed:** 100 **Inclusion criteria:** "Inclusion criteria were an age of 3–16 years and indications for a tonsillectomy according to the guidelines issued by the Ministry of Health and Social Welfare of the Republic of Croatia (upper air- way obstruction; recurrent tonsillitis involving seven episodes of inflammation per year, five episodes of inflammation per year in two subsequent years, or three episodes of inflammation per year in three subsequent years; recurrent peritonsillar abscess; obstructive sleep apnea; and suspected malignant tonsillar disease)." **Exclusion criteria:** none stated **Baseline characteristics:** • **Age: "**The mean age of both groups was six years (range 3–14)... There were no statistically significant differences between the groups in terms of age (p = 1)...." • **Gender:** "Fifty-two percent (52%) of patients were male and 48 (48%) were female... There were no statistically significant differences between the groups in terms of... gender (p = 1.)"
Interventions	**Coblation group:** n = 55 **Cold dissection group:** n = 54 **Use of additional interventions:** Conventional (blunt dissection) tonsillectomy utilised bipolar cautery for haemostasis. All patients had same surgeon, anaesthetist, anaesthetic plan, postoperative hospital stay, and analgesia and diet recommendations.
Outcomes	Postoperative analgesia usage, return to normal activity (postoperative day normal physical activity resumed), postoperative bleeding (study does not distinguish between primary and secondary), preoperative and postoperative C-reactive protein levels
Funding sources	No information available
Declarations of interest	Stated "No conflicts of interest in this study."
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement

Roje 2011 *(Continued)*

Random sequence generation (selection bias)	Low risk	"Children were selected from a large ENT database consisting of children who were designated to receive a tonsillectomy and were randomly placed in groups by second author based on randomization using a computer-generated random number."
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients and parents: low Personnel: high "The children's parents did not know which specific procedure (of the two possible) was performed on their child. Surgeon not blinded." Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Patients and parents: low Personnel: high "The children's parents did not know which specific procedure (of the two possible) was performed on their child. Surgeon not blinded."
Incomplete outcome data (attrition bias) All outcomes	High risk	**Participants lost to follow-up or excluded from analysis:** 9/109 • Coblation group: 5/55; 2 patients allocated to coblation did not receive coblation and were excluded from analysis; 3 patients who received coblation were lost to follow-up • Cold dissection group: 4/54 (8%) 4 patients lost to follow-up **Proportion of participants receiving treatment as allocated:** 107/109 (98%) • Coblation group: 53/55 (97%) • Cold dissection group: 54/54 (100%)
Selective reporting (reporting bias)	High risk	Inconsistency identified for single outcome: intraoperative blood loss. This outcome is described in the Statistics section but not in the Methods section. No numerical results for intraoperative blood loss are reported.
Other potential sources of bias	Unclear risk	Language in the manuscript describes those writing about the use of coblation as "technique pioneers," which could indicate a bias favouring a new technique

Shah 2002

Methods	Parallel, double-blinded randomised controlled trial with 6 months follow-up
Participants	**Setting:** academic hospital, United States **Sample size:** • **Number randomised:** 34 • **Number completed**: 34 **Inclusion criteria:** children aged 4 through 7 years, who were scheduled for day-surgery adenotonsillectomy (T&A) to treat adenotonsillar hypertrophy, from 10 August 1999 through 26 April 2000 **Exclusion criteria:** children 3 years and younger were excluded because of their higher risk for perioperative complications, severe obstructive sleep apnoea, craniofacial syndrome, developmental de-

Shah 2002 *(Continued)*

	lay, expressive language disorder, haematologic wound-healing disorder or necrotising dermatosis, implanted electrical device and mucopolysaccharidosis **Baseline characteristics:** • **Age:** overall range 4 to 7 years; coblation mean age 5.2 years; monopolar cautery mean age 5.4 years • **Gender:** coblation 11 males, 6 females; monopolar cautery 8 males, 9 females
Interventions	**Coblation group:** n = 17 **Monopolar electrocautery group:** n = 17 **Use of additional interventions:** All patients had concurrent adenoidectomy. Standardised perioperative medication and anaesthetic regimen (intravenous dexamethasone and antibiotics) and postoperative medication regimen (intravenous weight-based morphine) were used.
Outcomes	Surgical efficacy, intraoperative blood loss, duration of surgery, morphine use in PACU, postoperative pain, return to normal diet (reported by novel "diet score"), return to normal activity (reported by novel "activity score"), parental return to work, primary bleeding, secondary bleeding, use of morphine in PACU, adverse events (readmission, supplemental O_2, airway events, dehydration)
Funding sources	Public Health Service Research Grant MO1RR-00240 from NIH (National Institutes of Health). Equipment donated by ENTec division of ArthroCare Corporation.
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not described
Allocation concealment (selection bias)	Unclear risk	Method not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel, operative: high Personnel, follow-up: low Personnel, pathology: low
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel, operative: high Personnel, follow-up: low Personnel, pathology: low
Incomplete outcome data (attrition bias)	High risk	**Participants lost to follow-up:** 18/34 (53%)

Shah 2002 *(Continued)*

All outcomes		• Coblation group: 9/17 (53%) • Monopolar group: 9/17 (53%) **Proportion of participants receiving treatment as allocated:** 34/34 (100%) • Coblation group: 17/17 (100%) • Monopolar group: 17/17 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Unclear risk	Early termination of study due to "2 airway complications in the PMA group, one of [the authors] chose to terminate the study at 34 patients, rather than to complete enrollment to 60 patients."

Shapiro 2007

Methods	Parallel, single-blinded randomised controlled trial with 14 days follow-up
Participants	**Setting:** United States, academic hospital **Sample size:** • **Number randomised:** 47 • **Number completed:** 46 **Inclusion criteria:** children ages 2 to 16 undergoing outpatient adenotonsillectomy were offered enrollment over a 12-month period **Exclusion criteria:** patients with significant comorbidities such as systemic disease, known bleeding diathesis, craniofacial disorders, chromosomal abnormalities or motor/developmental delays were excluded **Baseline characteristics:** • **Age:** overall mean 6.7 years (range 2 to 16 years); coblation group mean age 7.39 years; cold dissection group mean age 6.1 years • **Gender:** overall 28 males and 18 females; coblation group 13 males and 10 females; cold dissection group 15 males and 8 females
Interventions	**Coblation group:** n = 24 **Cold dissection group:** n = 23 **Use of additional interventions:** All patients appear to have had concurrent adenoidectomy
Outcomes	Postoperative pain (Wong Baker FACES 0 to 5), daily analgesia usage (opioid and non-opioid), duration of surgery (total time, surgical time, tonsil-specific time), intraoperative blood loss, return to normal diet (normal diet, solid food), days to return to a normal caregiver routine, adverse events (phone calls, nausea, other), primary bleeding, secondary bleeding, time in recovery room
Funding sources	ArthroCare ENT thanked for donation of handpieces

Shapiro 2007 *(Continued)*

Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization occurred when the surgeon opened a preprinted, sealed, randomized envelope, revealing the technique to be used for each consecutive study patient." (Did not mention actual method of randomisation).
Allocation concealment (selection bias)	Low risk	"Randomization occurred when the surgeon opened a preprinted, sealed, randomized envelope, revealing the technique to be used for each consecutive study patient."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel, operative: high Personnel, recovery: low No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel, operative: high Personnel, recovery: high
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 0/47 (0%) • Coblation group: 0/24 (0%) • Cold dissection group: 0/23 (0%) **Proportion of participants receiving treatment as allocated:** 47/47 (100%) • Coblation group: 24/24 (100%) • Cold dissection group: 23/23 (100%) **Patients with incomplete data:** 1/47 (2%) • Coblation group: 1/24 (4%) • Cold dissection group: 0/23 (0%)
Selective reporting (reporting bias)	High risk	Did not report outcomes described in abstract/methods: duration of surgery, return to solid food diet, return to normal activity
Other potential sources of bias	Low risk	None identified

Stoker 2004

Methods	Parallel, double-blinded, multi-centre randomised controlled trial with 32 days follow-up
Participants	**Setting:** United States, academic and community-based hospitals

Stoker 2004 *(Continued)*

Sample size:

- **Number randomised:** 89
- **Number completed:** 85

Inclusion criteria: patients were recruited for study participation from the regular clinic pool at 3 centres. All study candidates had a history of tonsillar infection and/or obstructive tonsillar hypertrophy and were between the ages of 3 and 12 years.
Exclusion criteria: patients were ineligible for participation if they had active infection with fever 101.5° F, previous tonsillar surgery, history of peritonsillar abscess, systemic disease potentially causing coagulopathy, craniofacial anomaly, history of easy bruising or bleeding disorders, medical conditions that would result in lack of ability to interpret and convey degree of pain or discomfort to the caregiver, history of heart disease, diabetes or hypertension (systolic BP 160 mm Hg), and necessary tonsillar biopsy to rule out neoplasm.

Baseline characteristics:

- **Age: "**all study candidates … were between the ages of 3 and 12 years". Mean age for patients in both treatment groups was 6 +/- 3 years.
- **Gender:** coblation group 55% female; electrosurgery group 42% female

Interventions	**Coblation group:** n = 44 **Monopolar group:** n = 45 **Use of additional interventions:** Some patients underwent concurrent adenoidectomy
Outcomes	Primary bleeding, secondary bleeding, return to normal diet, return to normal activity, duration of surgery (time from first incision to complete haemostasis of the tonsillar bed, total time of surgery), "Pain-Free Status" (assessed by days of opioids, number of doses of opioids, subjective pain using Wong Baker FACES scale), adverse events (patient contact to physician regarding postoperative complications), intraoperative blood loss, surgeon rating of device (effectiveness for tissue removal, haemostasis), nausea, site-specific swelling during the 2 weeks after surgery, physical examination at postoperative day 16
Funding sources	"This study was supported by a grant from ArthroCare Corp., Sunnyvale, CA."
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not described
Allocation concealment (selection bias)	Unclear risk	Method not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel: high

Stoker 2004 *(Continued)*

		Patients and parents were blinded to assignment. Surgeons and operating room staff were not blinded. No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel: high Patients and parents were blinded to assignment. Surgeons and operating room staff not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	**Participants lost to follow-up:** 3/89 (3.4%) • Coblation group: 1/44 (2%) • Monopolar group: 2/45 (4%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	The authors' speculation regarding the "learning curve" with a new instrument is appropriately discussed.

Tan 2006

Methods	Parallel, double-blinded randomised controlled trial with 21 days follow-up "Double-blinded" refers to review of pain diaries and analysis not performed by the operating surgeon
Participants	**Setting:** hospital-based, Singapore **Sample size:** 72 initially recruited • **Number randomised:** 70 or 67 (unclear if the 2 patients who "changed mind before surgery" did so before or after randomisation and allocation) • **Number completed:** 67 **Inclusion criteria:** patients with a history of recurrent tonsillitis requiring tonsillectomy above and including the age of 18 years were recruited into the study **Exclusion criteria:** none reported **Baseline characteristics:** • **Age:** coblation mean age 27.0 years (SD 9.2 years), range 18 to 55 years; electrocautery mean age 25.2 years (SD 6.8), range 18 to 47 years • **Gender:** coblation 24 males, 5 females; electrocautery 27 males, 11 females
Interventions	**Coblation group:** n = 29 **Monopolar group:** n = 38 **Use of additional interventions:**

Tan 2006 *(Continued)*

	Standardised anaesthetic protocol including "fentanyl boluses of 25 mcg were given when blood pressure and heart rate increased by 20% or more during surgery. Following reversal and during recovery, intravenous tramadol 50 mg was given if the pain score exceeded 5 on a visual analogue scale (0 to 10)."
Outcomes	Postoperative pain (VAS 0 to 10), daily postoperative PO analgesia, return to normal diet, return to normal activity, return to painless swallowing, primary bleeding, secondary bleeding; postoperative satisfaction score; recommendation of surgery to friends or relatives
Funding sources	SHS/MOH Cluster Research Fund--Extra funding FY 2003
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	By computer randomisation
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: low Personnel (surgical): high Personnel (analytical): low "The patients were blinded with regard to their study group. The researcher (main author) analyzing the data and pain diary was blinded with regard to which treatment the patients had undergone. He (main author) was not involved with the tonsillectomy procedures." Surgical personnel were not blinded. No information provided on whether a single surgeon performed all of the operations or whether there was more than one surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Low risk	Participants: low Personnel (analytical): low "The patients were blinded with regard to their study group. The researcher (main author) analyzing the data and pain diary was blinded with regard to which treatment the patients had undergone. He (main author) was not involved with the tonsillectomy procedures." Surgical personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** 0/67 • Coblation group: 0/29 • Monopolar electrocautery group: 0/38 **Proportion of participants receiving treatment as allocated:** 70/72 (97%) 2 participants withdrew from the study before surgery. Their randomisation and allocation are unknown. • Coblation group: unknown • Monopolar electrocautery group: unknown

Tan 2006 *(Continued)*

		Participants with incomplete data (did not return pain diaries): 3/70 (4%) 3 participants failed to complete pain diaries. Their randomisation and allocation are not described. These patients were excluded from all analyses. • Coblation group: unknown • Monopolar electrocautery group: unknown Overall rate of attrition is low, 5/72 participants (6.9%), but we are unable to compare attrition rates between the 2 groups.
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Temple 2001

Methods	Randomised, parallel, single-blinded study with 9-day follow-up This study is described as "double blind" by the authors but the surgeon could not have been blinded. The study does not specifically state that the parents were not informed as to procedure performed.
Participants	**Setting:** United Kingdom, hospital **Sample size:** 38 • **Number randomised:** 38 • **Number completed:** 20 **Inclusion criteria:** paediatric patients who were listed for a routine tonsillectomy were recruited into the study. They all had a history of recurrent tonsillitis or had obstructive symptoms related to tonsillar hypertrophy. **Exclusion criteria:** history of tonsillitis within the 3 weeks prior to surgery; history of a bleeding disorder or other past medical history **Baseline characteristics:** • **Age:** overall mean age of 5.6 years, range 4 to 12 years • **Gender:** overall 19 males, 19 females
Interventions	**Coblation group:** n = 18 **Bipolar dissection group:** n = 20 **Use of additional interventions:** the same surgeon operated on all patients with the same anaesthetist in attendance, who gave them all the same immediate postoperative analgesia. All patients were discharged home the same day as the operation with paracetamol and Voltarol to take on an 'as required' basis over the next 9 days, as long as there were no contraindications to either drug.
Outcomes	Postoperative pain (VAS 1 to 10), postoperative healing of tonsillar fossa, return to normal diet, primary bleeding, secondary bleeding
Funding sources	ArthroCare donation of ArthroWand CoVac 70 suction wands

Temple 2001 *(Continued)*

Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation method not adequately described. "Patients were randomised, via a closed opaque envelope technique, to have bilateral coblation tonsillectomy ... or bilateral standard bipolar dissection tonsillectomy."
Allocation concealment (selection bias)	Unclear risk	The authors provide no description of the randomisation method, therefore it is possible that randomisation was inadequate and had a detectable pattern. If the investigators had uncovered this pattern, there would be no concealment of allocation.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants: not described Personnel: high Patient and family blinding not described. Operating surgeon and operating room personnel not blinded. Single surgeon.
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Participants: not described Personnel: high Patient and family blinding not described. Operating surgeon and operating room personnel not blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** • Coblation group: 8 • Bipolar dissection group: 10 **Proportion of participants receiving treatment as allocated:** 38/38 (100%) • Coblation group: 18/18 • Bipolar dissection group: 20/20
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	None identified

Wang 2005

Methods	Randomised study with 7-day follow-up. Other study design details not provided.
Participants	**Setting:** China **Sample size:** 100 • **Number randomised:** 100 • **Number completed:** 100

Wang 2005 *(Continued)*

Inclusion criteria: recurrent tonsillitis or hypertrophy
Exclusion criteria: not described

Baseline characteristics:

- **Age:** overall mean age of 5.6 years, range 4 to 47 years
  - Coblation: mean 7.5 years, range 4 to 47 years
  - Cold dissection: mean 9.2 years, range 4 to 45 years
- **Gender:** overall males 54, females 46
  - Coblation: males 28, females 22
  - Cold dissection: males 26, females 26

Interventions	**Coblation group:** n = 50 **Cold dissection group:** n = 50 **Use of additional interventions** None described
Outcomes	Postoperative pain (ordinal scale 1 to 4), intraoperative blood loss, duration of surgery, primary bleeding, secondary bleeding, wound healing (appearance of pseudomembrane), adverse events (complications)
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not described
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Cold dissection group: not report **Proportion of participants receiving treatment as allocated:** not reported • Coblation group: not reported

Wang 2005 *(Continued)*

		• Cold dissection group: not reported
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	Translated study

Wang 2009

Methods	Randomised study (method not described) with 10-day follow-up
Participants	**Setting:** China, hospital **Sample size:** 92 • **Number randomised:** 92 • **Number completed:** 92 **Inclusion criteria:** none stated **Exclusion criteria:** acute tonsillitis, systemic cardiac, circulatory, haematologic or immunologic co-morbidities, chromosome abnormalities or oculomandibulofacial syndrome **Baseline characteristics:** • **Age:** children, aged 4 to 14 years: coblation group, mean age 6.2; traditional dissection group, mean age 8.8 • **Gender:** 38 females, 54 males **Lost to follow-up:** not reported
Interventions	**Coblation group:** n = 46 **Cold (traditional) dissection:** n = 46 **Use of additional interventions:** None stated
Outcomes	Postoperative pain (Wong Baker FACES), return to normal diet, return to normal activity, duration of surgery, intraoperative complications, intraoperative bleeding, primary bleeding, secondary bleeding, tonsillar fossae healing
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement

Wang 2009 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not described
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Cold dissection group: not reported **Proportion of participants receiving treatment as allocated:** 92/92 (100%) • Coblation group: 46/46 (100%) • Cold dissection group: 46/46 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	Translated study

Wang 2010

Methods	Randomised study (method not described) with 9-day follow-up

Participants	**Setting:** China, hospital
	Sample size: 60
	• **Number randomised:** 60
	• **Number completed:** 60
	Inclusion criteria: chronic tonsillitis and adenoid hypertrophy
	Exclusion criteria: none stated
	Baseline characteristics:
	• **Age:**
	  * Coblation mean age 5.42 (SD 2.29)
	  * Cold dissection mean age 6.05 (SD 3.44)
	• **Gender:** females:33, males: 27

Interventions	**Coblation group:** n = 30 **Cold dissection group:**

Wang 2010 *(Continued)*

	n = 30 **Use of additional interventions:** All had adenoidectomy
Outcomes	Postoperative pain (scale 0 to 10), duration of surgery, intraoperative bleeding, primary bleeding, secondary bleeding, ability to eat solid food (measured in hours)
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not described
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Cold dissection group: not reported **Proportion of participants receiving treatment as allocated:** 60/60 (100%) • Coblation group: 30/30 (100%) • Cold dissection group: 30/30 (100%)
Selective reporting (reporting bias)	Unclear risk	No access to protocol. Insufficient information to judge.
Other potential sources of bias	Low risk	Translated study

Zhong 2006

Methods	Randomised study (method not described) with 10-day follow-up
Participants	**Setting:** China, hospital **Sample size:** 56

Zhong 2006 *(Continued)*

- **Number randomised:** 56
- **Number completed:** 56

Inclusion criteria: tonsil hypertrophy, chronic tonsillitis
Exclusion criteria: none reported

Baseline characteristics:

- **Age:**
  - Coblation group: 4 to 55 years, mean 17 years
  - Cold dissection: 3 to 54 years, mean 15 years
- **Gender:**
  - Coblation group: 11 females, 15 males
  - Cold dissection group: 11 females 19 males

Interventions	**Coblation group:** n = 26 **Cold dissection group:** n = 30 **Use of additional interventions:** None stated
Outcomes	Postoperative pain (VAS 0 to 10), intraoperative blood loss, duration of surgery, primary bleeding, secondary bleeding, return to normal diet, return to normal activity
Funding sources	No information available
Declarations of interest	No information available
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not described: ”Patients were randomly allocated"
Allocation concealment (selection bias)	Unclear risk	Method not described: ”Patients were randomly allocated"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Single surgeon
Blinding of outcome assessment (detection bias) Intraoperative blood loss	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	**Participants lost to follow-up:** not reported • Coblation group: not reported • Cold dissection group: not reported

Zhong 2006 *(Continued)*

		Proportion of participants receiving treatment as allocated: 56/56 (100%) • Coblation group: 26/26 (100%) • Cold dissection group: 30/30 (100%
Selective reporting (reporting bias)	High risk	Did not report outcomes as described in abstract/methods: outcome data for pain were collected through postoperative day 14 but results were reported only through postoperative day 10.
Other potential sources of bias	Low risk	Translated study

BP: blood pressure
IV: intravenous
NSAID: non-steroidal anti-inflammatory drug
PACU: post-anaesthetic care unit
PO: oral
SD: standard deviation
VAS: visual analogue scale
Underlined outcomes indicate outcomes considered in this review.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Arya 2003	INTERVENTION: Intracapsular tonsillectomy
Arya 2005	INTERVENTION: Intracapsular tonsillectomy
Arya 2006	INTERVENTION: Intracapsular tonsillectomy; letter
Chan 2004	INTERVENTION: Intracapsular tonsillectomy
Chang 2005	INTERVENTION: Intracapsular tonsillectomy
Di Rienzo Businco 2008	ALLOCATION: Not a randomised controlled trial
Fawzy 2012	ALLOCATION: Randomised by tonsil rather than by participant
Glade 2006	ALLOCATION: Not a randomised controlled trial: retrospective study
Hall 2004	ALLOCATION:

Study	Reason for exclusion
	Randomised by tonsil rather than by participant
Iqbal 2005	INTERVENTION: No coblation
Li 2017	COMPARISON: Coblation in both arms
Littlefield 2002	ALLOCATION: Randomised by tonsil rather than by participant
Littlefield 2005	ALLOCATION: Randomised by tonsil rather than by participant
Metcalfe 2017	ALLOCATION: Systematic review
Noordzij 2006	ALLOCATION: Randomised by tonsil rather than by participant
Ozkırış 2012	INTERVENTION: No coblation
Parker 2011	ALLOCATION: Not a randomised controlled trial: intervention determined according to surgical facility and day of the week
Patel 2004	ALLOCATION: Not a randomised controlled trial: intervention determined according to technique employed by surgeon caring for participant
Peak plasma	INTERVENTION: No coblation
Polites 2006	ALLOCATION: Randomised by tonsil rather than by participant
Roje 2004	Listed as a conference abstract but unable to obtain a copy; no response received to our request for more information
Saengpanich 2005	ALLOCATION: Randomised by tonsil rather than by participant
Salama 2012	INTERVENTION: Intracapsular tonsillectomy
Stephens 2009	INTERVENTION: No coblation
Timms 2002	ALLOCATION:

Study	Reason for exclusion
	Randomised by tonsil rather than by participant
Walner 2012	ALLOCATION: Not a randomised controlled trial: retrospective study

Characteristics of studies awaiting assessment *[ordered by study ID]*

Nithya 2016

Methods	Randomised study with 7 days follow-up
Participants	**Setting:** India, tertiary care hospital **Sample size:** • **Number randomised:** 60 • **Number completed:** 60 **Inclusion criteria:** "ages 7-13 fulfilling the sign guidelines for adenotonsillectomy with sore throats due to tonsillitis…" **Exclusion criteria:** known bleeding disorder or immune-compromised status **Baseline characteristics:** • Cold dissection mean 9.1 years (range 7 to 12); 12 male, 18 female • Coblation mean 8.8 years (range 7 to 13); 14 male, 16 female
Interventions	Coblation tonsillectomy versus cold tonsillectomy
Outcomes	Postoperative pain ("Wong Baker visual analog scale"), intraoperative bleeding, duration of surgery and postoperative bleeding (study does not distinguish between primary and secondary)
Notes	—

Trotter 2003

Methods	—
Participants	—
Interventions	—
Outcomes	—
Notes	Identified by previous review (Burton 2007). No further information.

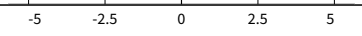
DATA AND ANALYSES

Comparison 1. Coblation versus alternative tonsillectomy techniques

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain day 1	6	538	Std. Mean Difference (IV, Random, 95% CI)	-0.79 [-1.38, -0.19]
1.1 Cold techniques	6	478	Std. Mean Difference (IV, Random, 95% CI)	-0.80 [-1.48, -0.11]
1.2 Hot techniques	1	60	Std. Mean Difference (IV, Random, 95% CI)	-0.74 [-1.29, -0.18]
2 Pain day 3	5	401	Std. Mean Difference (IV, Random, 95% CI)	-0.44 [-0.97, 0.09]
3 Pain day 7	5	420	Std. Mean Difference (IV, Random, 95% CI)	-0.01 [-0.22, 0.19]
3.1 Cold techniques	5	360	Std. Mean Difference (IV, Random, 95% CI)	0.05 [-0.16, 0.26]
3.2 Hot techniques	1	60	Std. Mean Difference (IV, Random, 95% CI)	-0.43 [-0.97, 0.11]
4 Intraoperative blood loss (in ml)	9		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.1 Cold techniques	9		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.2 Hot techniques	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
5 Primary bleeding	25	2055	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.48, 2.05]
5.1 Cold techniques	15	1207	Risk Ratio (M-H, Fixed, 95% CI)	1.16 [0.47, 2.85]
5.2 Hot techniques	11	848	Risk Ratio (M-H, Fixed, 95% CI)	0.73 [0.20, 2.60]
6 Secondary bleeding	25	2118	Risk Ratio (M-H, Fixed, 95% CI)	1.36 [0.95, 1.95]
6.1 Cold techniques	15	1270	Risk Ratio (M-H, Fixed, 95% CI)	1.44 [0.95, 2.19]
6.2 Hot techniques	11	848	Risk Ratio (M-H, Fixed, 95% CI)	1.19 [0.60, 2.36]
7 Time to return to normal diet	5		Mean Difference (IV, Random, 95% CI)	Totals not selected
8 Time to return to normal activity	4		Mean Difference (IV, Random, 95% CI)	Totals not selected
9 Duration of surgery	11		Mean Difference (IV, Random, 95% CI)	Totals not selected
9.1 Cold techniques	7		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
9.2 Hot techniques	5		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

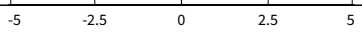
Analysis 1.1. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 1 Pain day 1.

Study or subgroup	Coblation N	Coblation Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
1.1.1 Cold techniques							
Anthony 2006	31	2.3 (0.6)	48	2.7 (0.8)		14.52%	-0.48[-0.94,-0.03]
Elbadawey 2015	20	3.9 (0.7)	40	4.5 (0.5)		13.86%	-1.04[-1.61,-0.47]
Gustavii 2010	28	50 (29)	29	62 (27)		14.13%	-0.42[-0.95,0.1]
Paramasivan 2012	50	1.3 (1)	50	1.9 (1.3)		14.84%	-0.49[-0.89,-0.09]
Philpott 2005	42	5 (2.6)	48	4.7 (2.3)		14.75%	0.13[-0.29,0.54]
Wang 2009	46	1.2 (0.4)	46	2.8 (0.8)		13.95%	-2.54[-3.1,-1.99]
Subtotal ***	**217**		**261**			**86.04%**	**-0.8[-1.48,-0.11]**
Heterogeneity: Tau^2=0.67; Chi^2=61.82, df=5(P<0.0001); I^2=91.91%							
Test for overall effect: Z=2.27(P=0.02)							
1.1.2 Hot techniques							
Elbadawey 2015	20	3.9 (0.7)	40	4.3 (0.4)		13.96%	-0.74[-1.29,-0.18]
Subtotal ***	**20**		**40**			**13.96%**	**-0.74[-1.29,-0.18]**
Heterogeneity: Not applicable							
Test for overall effect: Z=2.61(P=0.01)							
Total ***	**237**		**301**			**100%**	**-0.79[-1.38,-0.19]**
Heterogeneity: Tau^2=0.57; Chi^2=61.89, df=6(P<0.0001); I^2=90.31%							
Test for overall effect: Z=2.61(P=0.01)							
Test for subgroup differences: Chi^2=0.02, df=1 (P=0.9), I^2=0%							



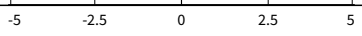
Analysis 1.2. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 2 Pain day 3.

Study or subgroup	Coblation N	Coblation Mean(SD)	Cold dissection N	Cold dissection Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
Anthony 2006	31	2.6 (0.8)	49	2.7 (0.7)		20.11%	-0.21[-0.66,0.24]
Gustavii 2010	28	60 (29)	29	65 (24)		19.18%	-0.19[-0.71,0.33]
Paramasivan 2012	50	0.7 (0.8)	50	1.3 (1.1)		20.75%	-0.58[-0.98,-0.18]
Philpott 2005	36	5.8 (2.5)	36	5.3 (2.4)		19.95%	0.2[-0.27,0.66]
Wang 2009	46	1.7 (0.5)	46	2.6 (0.8)		20.01%	-1.41[-1.87,-0.96]
Total ***	**191**		**210**			**100%**	**-0.44[-0.97,0.09]**
Heterogeneity: Tau^2=0.31; Chi^2=26.88, df=4(P<0.0001); I^2=85.12%							
Test for overall effect: Z=1.64(P=0.1)							

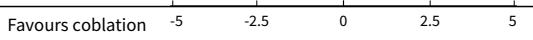


Analysis 1.3. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 3 Pain day 7.

Study or subgroup	Coblation N	Coblation Mean(SD)	Comparator N	Comparator Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
1.3.1 Cold techniques							
Anthony 2006	32	2.2 (0.8)	49	2.3 (0.9)		19.1%	-0.15[-0.6,0.3]

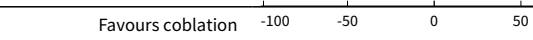


Study or subgroup	Coblation		Comparator		Std. Mean Difference	Weight	Std. Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI		Random, 95% CI
Elbadawey 2015	20	1.5 (0.5)	40	1.5 (0.5)		13.61%	0[-0.54,0.54]
Gustavii 2010	28	59 (30)	29	50 (27)		14.3%	0.31[-0.21,0.83]
Philpott 2005	34	5.8 (3)	36	5.1 (2.8)		17.32%	0.26[-0.21,0.73]
Wang 2009	46	1.5 (0.6)	46	1.5 (0.5)		22.32%	-0.07[-0.48,0.34]
Subtotal ***	**160**		**200**			**86.66%**	**0.05[-0.16,0.26]**
Heterogeneity: Tau²=0; Chi²=2.87, df=4(P=0.58); I²=0%							
Test for overall effect: Z=0.47(P=0.64)							
1.3.2 Hot techniques							
Elbadawey 2015	20	1.5 (0.5)	40	1.7 (0.4)		13.34%	-0.43[-0.97,0.11]
Subtotal ***	**20**		**40**			**13.34%**	**-0.43[-0.97,0.11]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.55(P=0.12)							
Total ***	**180**		**240**			**100%**	**-0.01[-0.22,0.19]**
Heterogeneity: Tau²=0.01; Chi²=5.48, df=5(P=0.36); I²=8.7%							
Test for overall effect: Z=0.11(P=0.91)							
Test for subgroup differences: Chi²=2.6, df=1 (P=0.11), I²=61.61%							



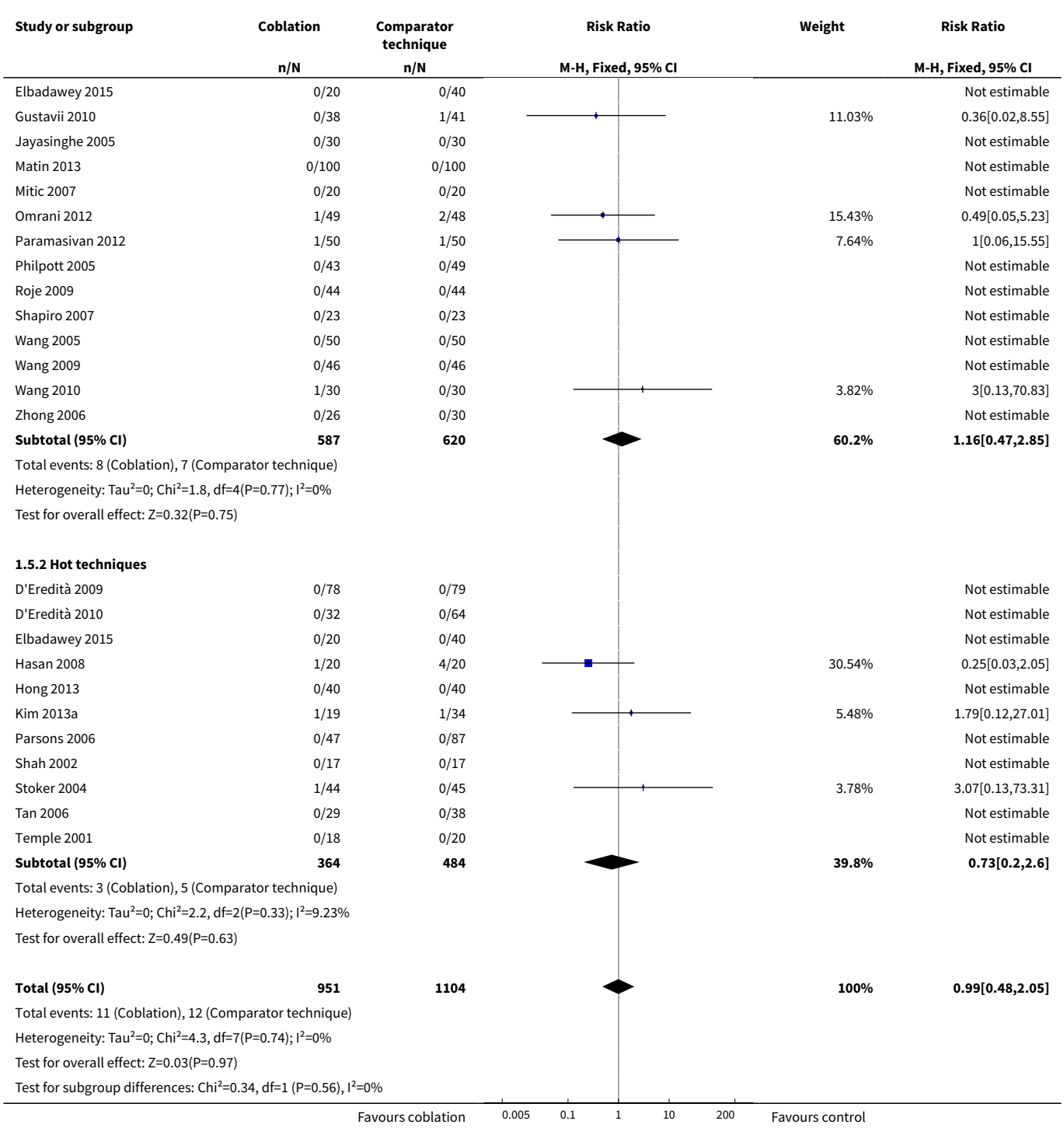
Analysis 1.4. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 4 Intraoperative blood loss (in ml).

Study or subgroup	Coblation		Comparator		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Fixed, 95% CI
1.4.1 Cold techniques						
Elbadawey 2015	20	20 (2.7)	40	30 (3.2)		-10[-11.52,-8.48]
Jayasinghe 2005	30	19.5 (18.7)	30	69 (65)		-49.45[-73.64,-25.26]
Omrani 2012	47	103.4 (28.7)	47	161.5 (46.4)		-58.1[-73.7,-42.5]
Parsons 2006	46	21.5 (32.6)	87	14.8 (19.8)		6.7[-3.6,17]
Roje 2009	44	10.8 (3.4)	44	27.1 (13.2)		-16.25[-20.28,-12.22]
Shah 2002	17	90.9 (35.3)	17	83.8 (46.4)		7.1[-20.61,34.81]
Wang 2005	50	11 (4.1)	50	24 (9.8)		-13[-15.94,-10.06]
Wang 2009	46	6.8 (3.4)	46	30.7 (7)		-23.87[-26.12,-21.62]
Wang 2010	30	5.2 (3.5)	30	145.6 (32.5)		-140.39[-152.07,-128.71]
1.4.2 Hot techniques						
Elbadawey 2015	20	20 (2.7)	40	25 (2.6)		-5[-6.42,-3.58]

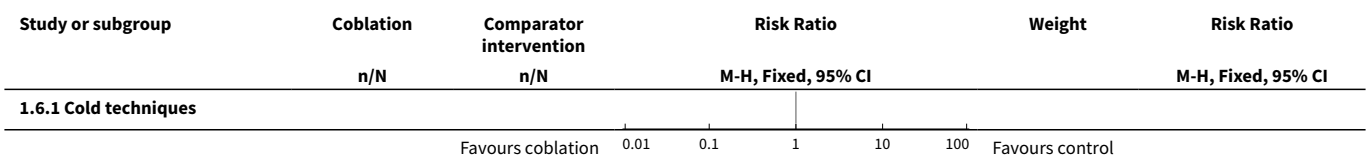


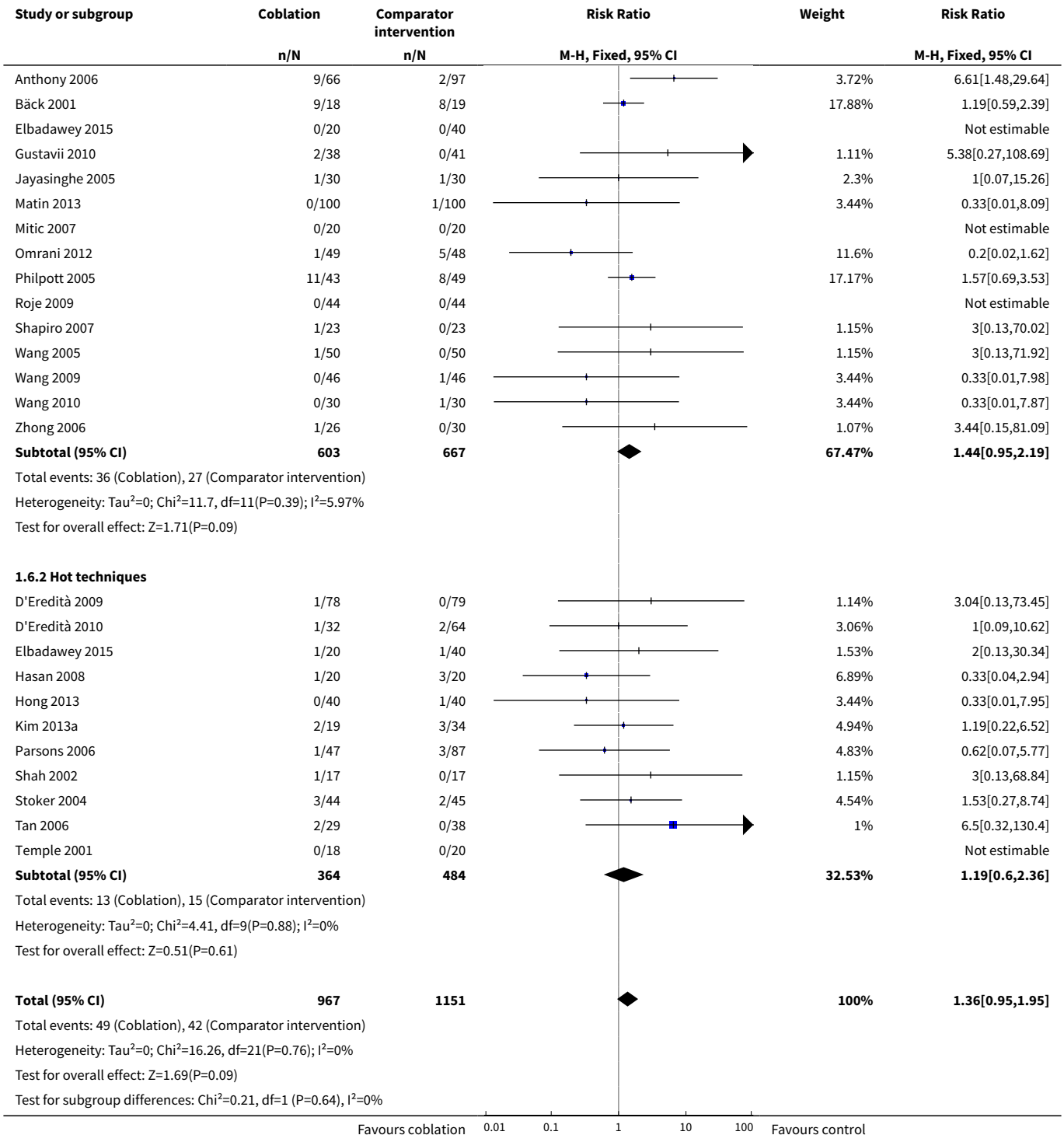
Analysis 1.5. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 5 Primary bleeding.

Study or subgroup	Coblation	Comparator technique	Risk Ratio	Weight	Risk Ratio
	n/N	n/N	M-H, Fixed, 95% CI		M-H, Fixed, 95% CI
1.5.1 Cold techniques					
Bäck 2001	5/18	3/19		22.29%	1.76[0.49,6.31]



Analysis 1.6. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 6 Secondary bleeding.



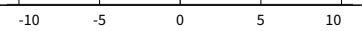


Analysis 1.7. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 7 Time to return to normal diet.

Study or subgroup	Coblation		Comparator		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI	Random, 95% CI
Omrani 2012	47	6.3 (1.1)	47	9.3 (1.3)		-2.98[-3.46,-2.5]
Philpott 2005	33	8.8 (4.5)	34	6.6 (3.8)		2.2[0.22,4.18]
Stoker 2004	44	7.4 (1.9)	45	6.7 (1.8)		0.7[-0.07,1.47]
Tan 2006	29	11.1 (3.8)	38	12.5 (4)		-1.4[-3.28,0.48]
Zhong 2006	26	10.1 (3.6)	30	12.2 (2.6)		-2.1[-3.77,-0.43]

Analysis 1.8. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 8 Time to return to normal activity.

Study or subgroup	Coblation		Comparator		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI	Random, 95% CI
Omrani 2012	47	7.4 (1.2)	47	11.7 (1.7)		-4.34[-4.92,-3.76]
Philpott 2005	36	10.1 (4.5)	36	10.5 (4.4)		-0.39[-2.46,1.68]
Stoker 2004	44	7 (1.9)	45	6.9 (1.8)		0.1[-0.67,0.87]
Tan 2006	29	7.9 (4.9)	38	10 (6.3)		-2.1[-4.78,0.58]



Analysis 1.9. Comparison 1 Coblation versus alternative tonsillectomy techniques, Outcome 9 Duration of surgery.

Study or subgroup	Coblation		Comparator		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI	Random, 95% CI
1.9.1 Cold techniques						
Elbadawey 2015	20	10 (3.1)	40	20 (3.1)		-10[-11.67,-8.33]
Jayasinghe 2005	30	14.4 (4.8)	30	23 (6.4)		-8.6[-11.47,-5.73]
Omrani 2012	47	27.3 (4.8)	47	31 (5.4)		-3.7[-5.77,-1.63]
Shapiro 2007	23	5 (1)	23	7.8 (1.1)		-2.8[-3.4,-2.2]
Wang 2005	50	9.8 (3)	50	20.9 (7.5)		-11.1[-13.34,-8.86]
Wang 2010	30	32.7 (8.7)	30	56.4 (10.8)		-23.75[-28.7,-18.8]
Zhong 2006	26	14.5 (7.2)	30	28.4 (10.9)		-13.9[-18.68,-9.12]
1.9.2 Hot techniques						
Elbadawey 2015	20	10 (3.1)	40	15 (2.6)		-5[-6.58,-3.42]
Kim 2013a	19	19.1 (5.5)	34	27.4 (8.1)		-8.3[-11.97,-4.63]
Parsons 2006	42	28.9 (13.5)	86	26.4 (10)		2.5[-2.1,7.1]
Shah 2002	17	23.8 (7.9)	17	16.2 (3.2)		7.6[3.55,11.65]
Stoker 2004	44	7.8 (4.9)	45	8 (2.7)		-0.2[-1.85,1.45]

APPENDICES

Appendix 1. Search strategies

CENTRAL	PubMed	EMBASE (Ovid)
#1 MeSH descriptor Tonsillectomy explode all trees #2 tonsillectom* OR tonsilectom* #3 adenotonsillectom* OR adenotonsilectom* #4 MeSH descriptor Palatine Tonsil explode all trees with qualifier: SU #5 (#1 OR #2 OR #3 OR #4) #6 MeSH descriptor Tonsillitis explode all trees #7 MeSH descriptor Palatine Tonsil explode all trees #8 tonsil* #9 adenotonsil* #10 #6 OR #7 OR #8 OR #9 #11 MeSH descriptor Surgical Procedures, Operative explode all trees #12 surg* OR excis* OR extract* OR remov* OR dissect* #13 #11 OR #12 #14 (#10 AND #13) #15 (#5 OR #14) #16 coblat* OR ablat* OR bipolar probe* OR radiofrequenc* OR plasma #17 ionised NEAR field #18 #16 OR# 17 #19 (#15 AND #18)	#1 "tonsillectomy" [Mesh] #2 tonsillectom* [tiab] OR tonsilectom* [tiab] OR adenotonsillectom* [tiab] OR adenotonsilectom* [tiab] #3 "Palatine Tonsil/surgery"[Mesh] #4 #1 OR #2 OR 3 #5 "tonsillitis" [Mesh] #6 "palatine tonsil" [Mesh] #7 tonsil* [tiab] OR adenotonsil* [tiab] #8 #5 OR #6 OR #7 #9 "Surgical Procedures, Operative" [Mesh] #10 surg* [tiab] OR excis* [tiab] OR extract* [tiab] OR remov* [tiab] OR dissect* [tiab] #11 #9 OR #10 #12 #8 AND #11 #13 #4 OR #12 #14 coblat* [tiab] OR ablat* [tiab] OR "bipolar probe*" [tiab] OR radiofrequenc* [tiab] OR plasma [tiab] #15 ionised [tiab] AND field [tiab] #16 #14 OR #15 #17 #13 AND #16	1 exp Tonsillectomy/ 2 (tonsillectom* or tonsilectom* or adenotonsillectom* or adenotonsilectom* or tonsillotom* or tonsilotom*).tw. 3 exp Tonsil/ 4 exp Tonsillitis/ 5 (tonsil* or adenotonsil*).tw. 6 exp Surgery/ 7 (surg* or excis* or extract* or remov*).tw. 8 4 or 3 or 5 9 6 or 7 10 8 and 9 11 1 or 10 or 2 12 (coblat* or ablat* or "bipolar probe*" or radiofrequenc* or plasma).tw. 13 (ionised and field*).tw. 14 13 or 12 15 11 and 14

Web of Science (web of Knowledge)	CINAHL (EBSCO)	Trial Registries
#1 TS=(tonsillectom* OR tonsilectom* OR adenotonsillectom* OR adenotonsilectom*) #2 TS=(tonsil* OR adenotonsil*) #3 TS=(surg* OR excis* OR extract* OR remov* OR dissect*) #4 #3 AND #2 #5 #4 OR #1 #6 TS=(coblat* OR ablat* OR "bipolar probe*" OR radiofrequenc* OR plasma) #7 TS=(ionised AND field) #8 #7 OR #6 #9 #8 AND #5	S1 TX tonsillectom* OR tonsilectom* OR adenotonsillectom* OR adenotonsilectom* S2 (MH "Tonsil/SU") OR (MH "Tonsillectomy") S3 (MH "Tonsillitis") S4 (MH "Tonsil") S5 TX tonsil* OR adenotonsil* S6 s3 or S4 or S5 S7 (MH "Surgery, Operative") S8 TX surg* OR excis* OR extract* OR remov* OR dissect* S9 S7 or s8 S10 S6 and s9 S11 S1 or S2 or S10 S12 TX coblat* OR ablat* OR "bipolar probe*" OR radiofrequenc* OR plasma S13 TX ionised AND field S14 S12 OR S13 S15 S11 AND S1	**ICTRP** tonsil* AND coblat* OR adenotonsil* AND coblat* OR tonsil* AND ablat* OR adenotonsil* AND ablat* OR tonsil* AND plasma OR adenotonsil* AND plasma OR tonsil* AND bipolar OR adenotonsil* AND bipolar OR tonsil* AND radiofrequency OR adenotonsil* AND radiofrequency OR tonsil* AND ionised OR adenotonsil* AND ionised **Clinicaltrials.gov** (tonsillectomy OR tonsillectomies OR adenotonsillectomy OR adenotonsillectomies OR tonsil OR adenotonsil) AND (coblation OR ablation OR bipolar OR radiofrequency OR plasma OR ionised)

WHAT'S NEW

Date	Event	Description
27 July 2017	New citation required but conclusions have not changed	Following full new searches in April 2017, we included an additional 20 studies in the review, bringing the total included to 29. We excluded a further 11 studies. We revised the inclusion criteria to include studies that performed concurrent adenoidectomy or ear tube insertion. We refined the review outcome measures (see Differences between protocol and review). Four new authors contributed to this review (Pynnonen, Brinkmeier, Chong and Thorne). The evidence remains too fragmented to draw any strong conclusions on the relative effectiveness and safety of the coblation technique compared to other tonsillectomy techniques.
20 April 2017	New search has been performed	Searches updated 20 April 2017.

HISTORY

Protocol first published: Issue 1, 2004
Review first published: Issue 3, 2007

Date	Event	Description
21 October 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Melissa A Pynnonen: data extraction, analysis, writing, editing.

Marc C Thorne: data extraction, analysis, writing.

Martin J Burton: oversight of methods, editing.

Lee Yee Chong: oversight of methods, data analysis, writing, editing.

Jennifer V Brinkmeier: data extraction, analysis, writing, editing.

DECLARATIONS OF INTEREST

Melissa Pynnonen: none known.

Marc C Thorne: none known

Martin J Burton: Professor Martin Burton is joint Co-ordinating Editor of Cochrane ENT, but had no role in the editorial process for this review.

Lee Yee Chong: none known.

Jennifer V Brinkmeier: none known.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- National Institute for Health Research, UK.

  Infrastructure funding for Cochrane ENT

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We revised the protocol for this update; the primary changes are in the choice of outcomes:

- We revised the inclusion criteria to include studies that performed concurrent adenoidectomy or ear tube insertion.
- We removed the primary outcome postoperative analgesia and the secondary outcome length of hospital stay. Based on prior experience these outcomes are heavily influenced by institutional protocols and cultural norms and they are inconsistently reported.
- We preserved the requirement that pain is measured with a validated pain scale and we have specified postoperative days 1, 3 and 7 as relevant time points for pain measurement. Based on the authors' clinical experience, these are clinically relevant time points that have the additional benefit of being commonly reported across studies, lending themselves to meta-analysis. Postoperative day 1 was not in the initial protocol due to concerns that it would be heavily influenced by the anaesthetic regimen, an unmeasured confounding variable. However, since these are randomised trials relative pain severity can still be reliably measured and we thought pain at this very early time point was clinically relevant.
- We report blood loss as separate outcomes of 'intraoperative blood loss', 'primary blood loss' and 'secondary blood loss' to account for the different nature and timing of the blood losses.
- We classified comparator tonsillectomy procedures into 'hot' and 'cold' tonsillectomy techniques, based on the instrument used for the tonsillectomy, acknowledging that additional techniques may used for haemostasis.
- We added details of planned subgroup analyses.

INDEX TERMS

Medical Subject Headings (MeSH)

Catheter Ablation [adverse effects] [*methods]; Hypertrophy [surgery]; Pain, Postoperative [*prevention & control]; Palatine Tonsil [pathology] [surgery]; Postoperative Hemorrhage [*prevention & control]; Randomized Controlled Trials as Topic; Sodium Chloride [*therapeutic use]; Tonsillectomy [adverse effects] [instrumentation] [*methods]; Tonsillitis [surgery]

MeSH check words

Adult; Child; Humans